# ATTACHMENT 8 – REMEDY SELECTION REPORTS FOR GREEN LANDFILL

# Final Groundwater and Non-Groundwater Corrective Action Remedy Selection Report

Green Landfill
Sebree Station
Webster County, Kentucky

Prepared for:

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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

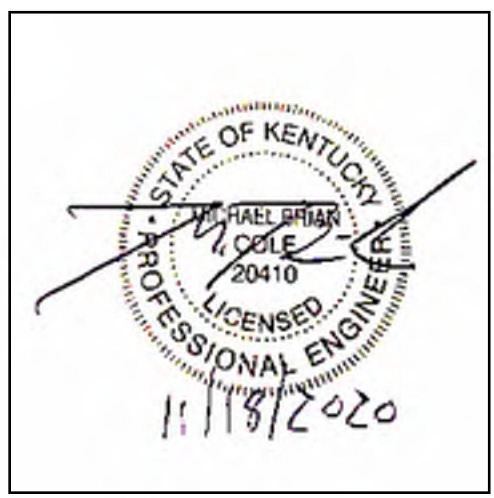
________________________________

*Printed Name*

*11/18/2020*

________________________________

*Date*



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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 dicuss 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 form 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 evalauted 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 intendes 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 Statue (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 chracterization 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 regualtions 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 perforrm corrective action for eligible non-groundwater releases at a CCR unit. In alignment with corrective actions being performed to address the NOVs received from the KDWM for unpermitted discharges and seepage emanating from the Unit, BREC perfomed 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 intiated 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 (refered to as the Deep Seep Collection Trench) to address seeps adjacent to the Green River; and
- Construction of a series of collection trenchs along the north side of the Green Landfill (refered 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 Janaury 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 NOVs 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 underling 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 $2 \times 10^{-5}$ to $3 \times 10^{-3}$ 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.

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

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

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

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

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**.

## 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 refences 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 remining 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 in 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 |

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, theses measure 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 consider 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.

AECOM, 2019. Assessment of Corrective Measures Under the CCR Rule; Green Station CCR Landfill, Green Station, Webster County, Kentucky.

AECOM, 2019. Assessment of Corrective Measures, Non-Groundwater Releases Under the CCR Rule; Green Station CCR Landfill, Green Station, Webster County, Kentucky.

AECOM, 2020. 2019 Annual Groundwater Monitoring and Corrective Action Report, Sebree Generating Station, Henderson and Webster Counties Kentucky.

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.

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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

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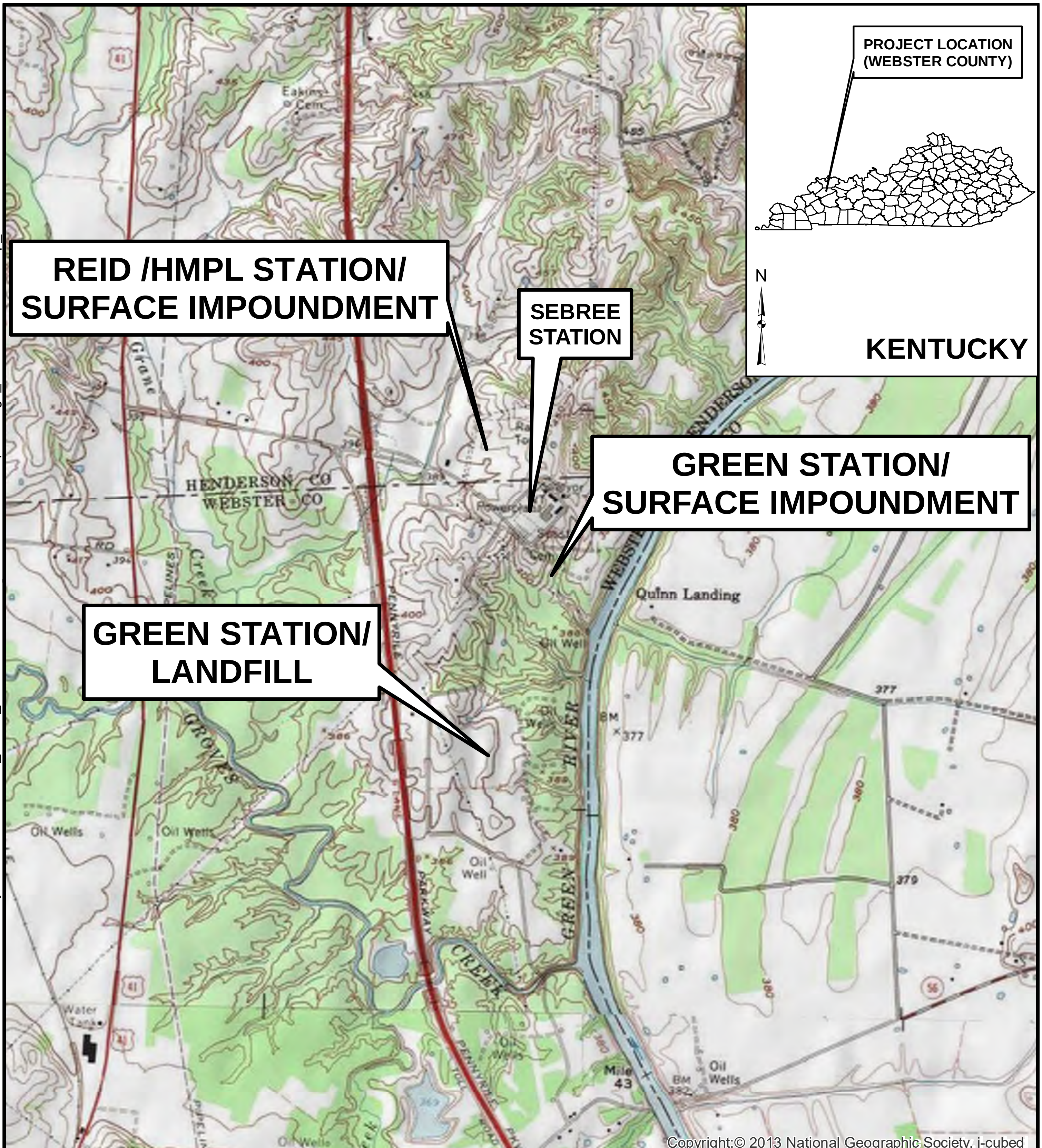



Big Rivers Electric Corporation

*Sebree Station*
*Webster County, Kentucky*

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

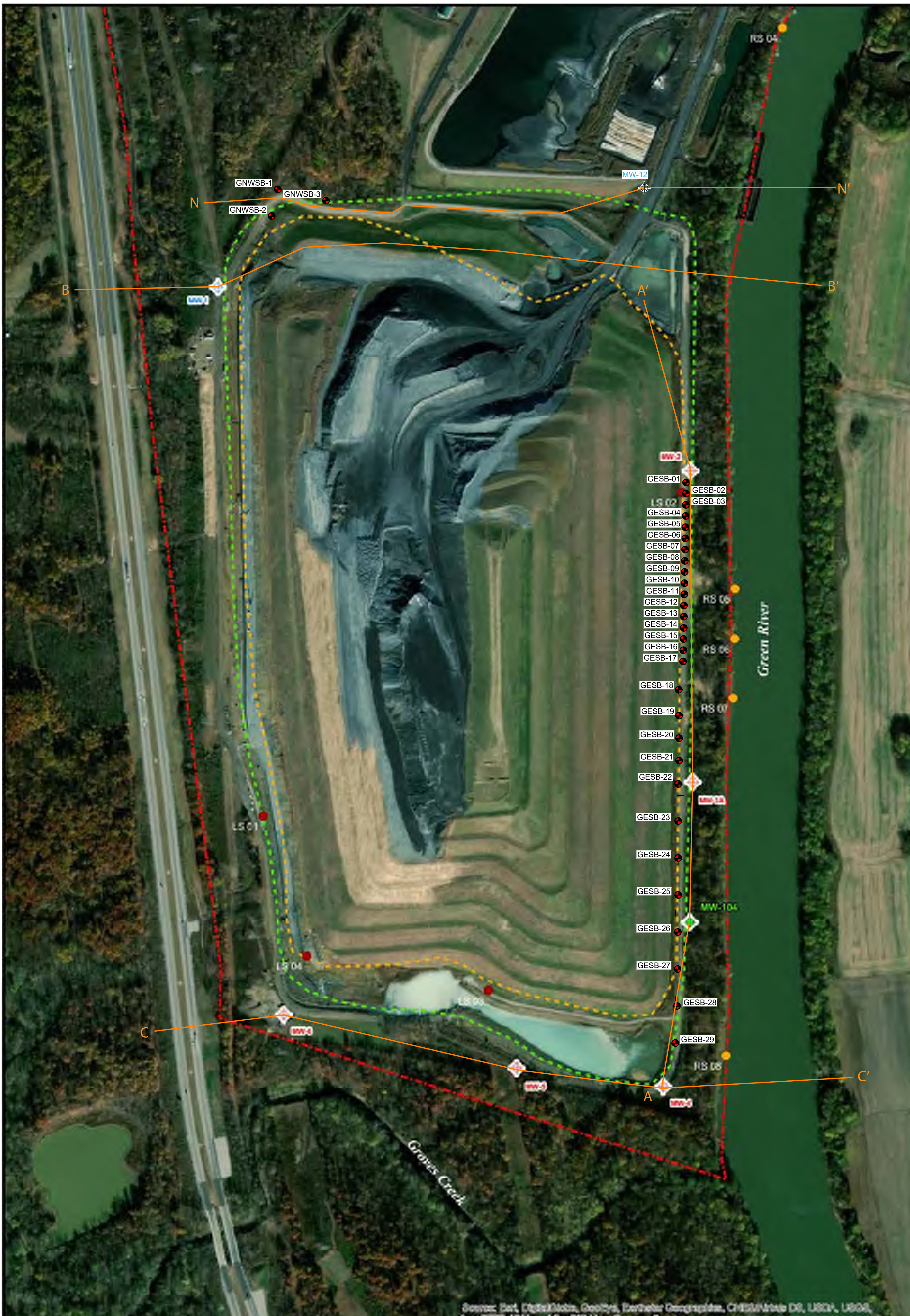
ROBARDS QUADRANGLE
DELAWARE QUADRANGLE
(FROM ARCGIS ONLINE Copyright:© 2011 National Geographic Society, i-cubed)

0 2,000 4,000 Feet

N

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
- Upgradient CCR Monitoring Well
- Characterization Well
- A —— A′ Transect Line
- GESB-01 Seeps Investigation Borings
- Landfill Seep Sample
- River Seep Sample

0 400 800
Feet

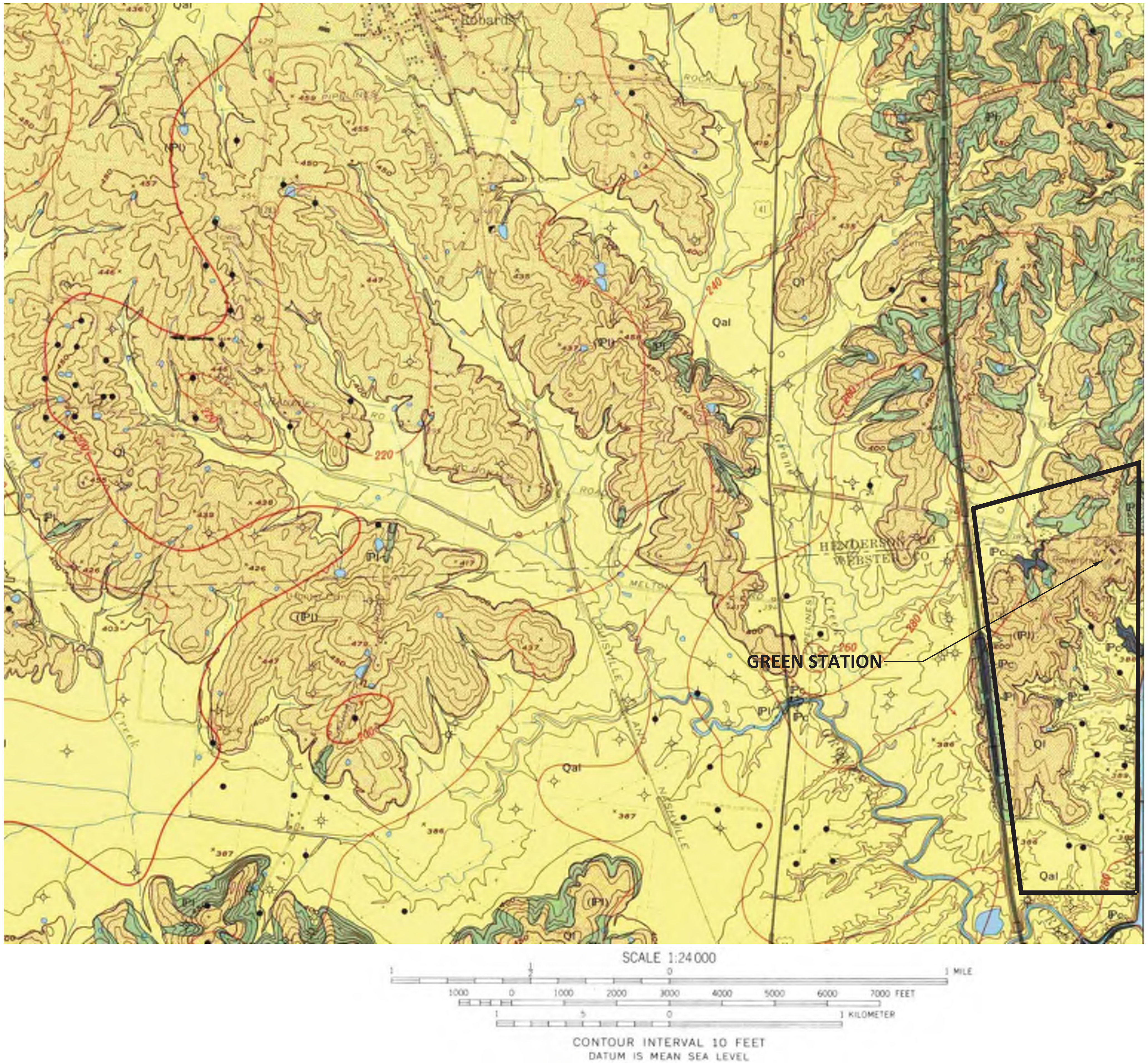
N

Big Rivers

*Green Station*
*Webster County, Kentucky*

FIGURE 2
WELL LOCATION MAP

| | |
|---|---|
| DATE:06/04/2019 | SCALE: 1IN = 300 FEET |
| CREATED BY: DAS | |
| JOB NO. 60602364 | |




## EXPLANATION

| | | |
|---|---|---|
| *Pleistocene and Holocene* | Qal — Alluvium | QUATERNARY |
| *Pleistocene* | Ql — Loess<br>*Adapted in part from soil map of Henderson County (Converse and Cox, 1967)* | QUATERNARY |
| *Upper Pennsylvanian* | Pl / m / Pl — Lisman Formation<br>*m, base of Madisonville Limestone Member* | PENNSYLVANIAN |
| *Middle Pennsylvanian* | Pc — Carbondale Formation | PENNSYLVANIAN |

Formation symbols enclosed in parentheses where units concealed by mapped surficial deposits

Contact or key bed
*Dashed where inferred; dotted where concealed. Triangles indicate selected localities where contacts were well exposed at time of mapping*

Strike and dip of beds

Structure contours
*Drawn on base of No. 9 coal bed; projected where contoured horizon is missing. Arrows indicate direction of dip. Contour interval 20 feet*

Outline of area where No. 9 coal bed is missing

DRILL HOLES FROM WHICH SUBSURFACE STRUCTURAL DATA WERE OBTAINED, AS OF JANUARY 1, 1971

Dry hole

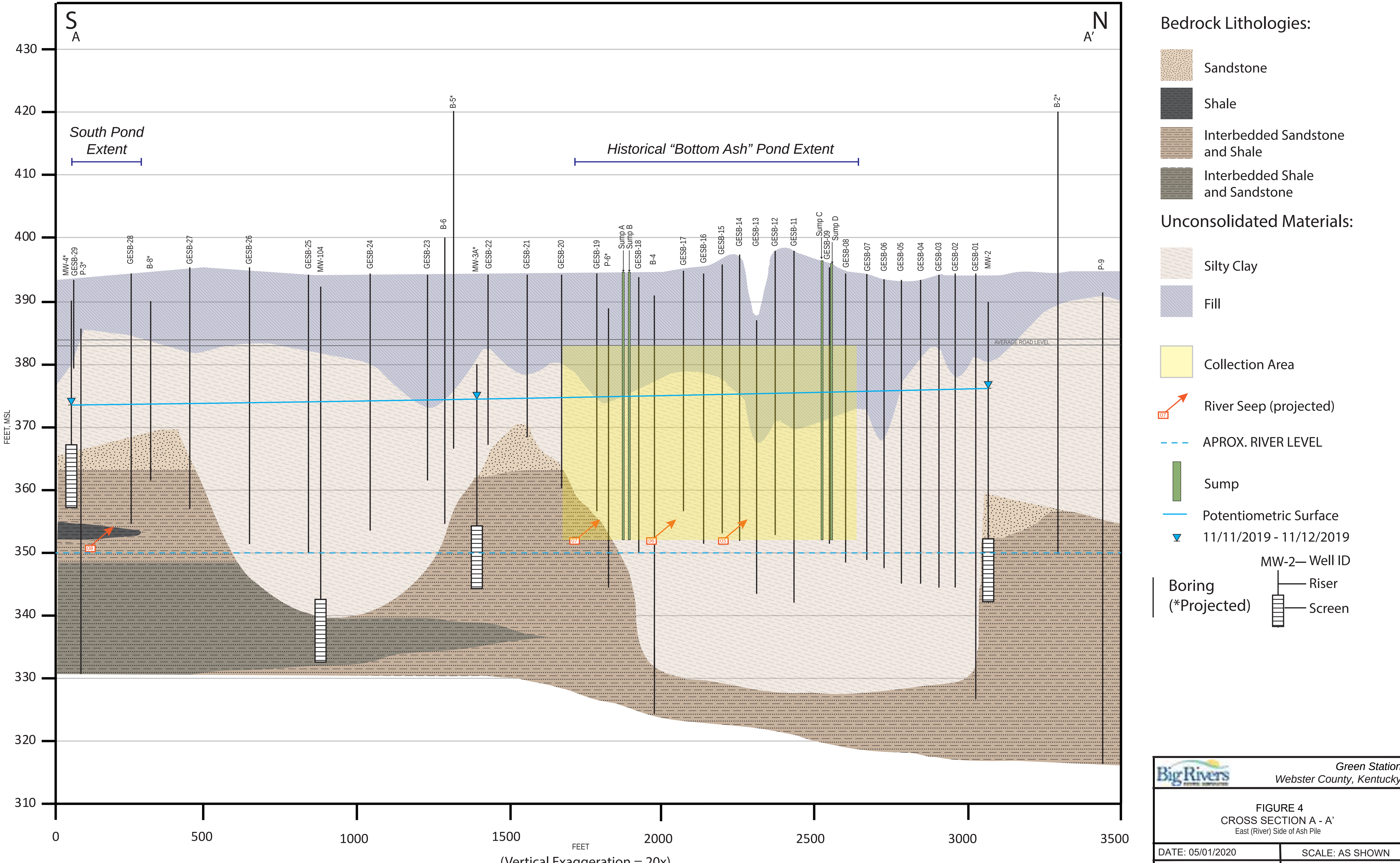
Oil well

Big Rivers

*Green Station*
*Webster County, Kentucky*

FIGURE 3
SITE GEOLOGIC MAP
(KENTUCKY GEOLOGICAL SURVEY)

| | |
|---|---|
| DATE: 05/21/2019 | SCALE: AS SHOWN |
| CREATED BY: DAS | |
| JOB NO. 60602364 | |

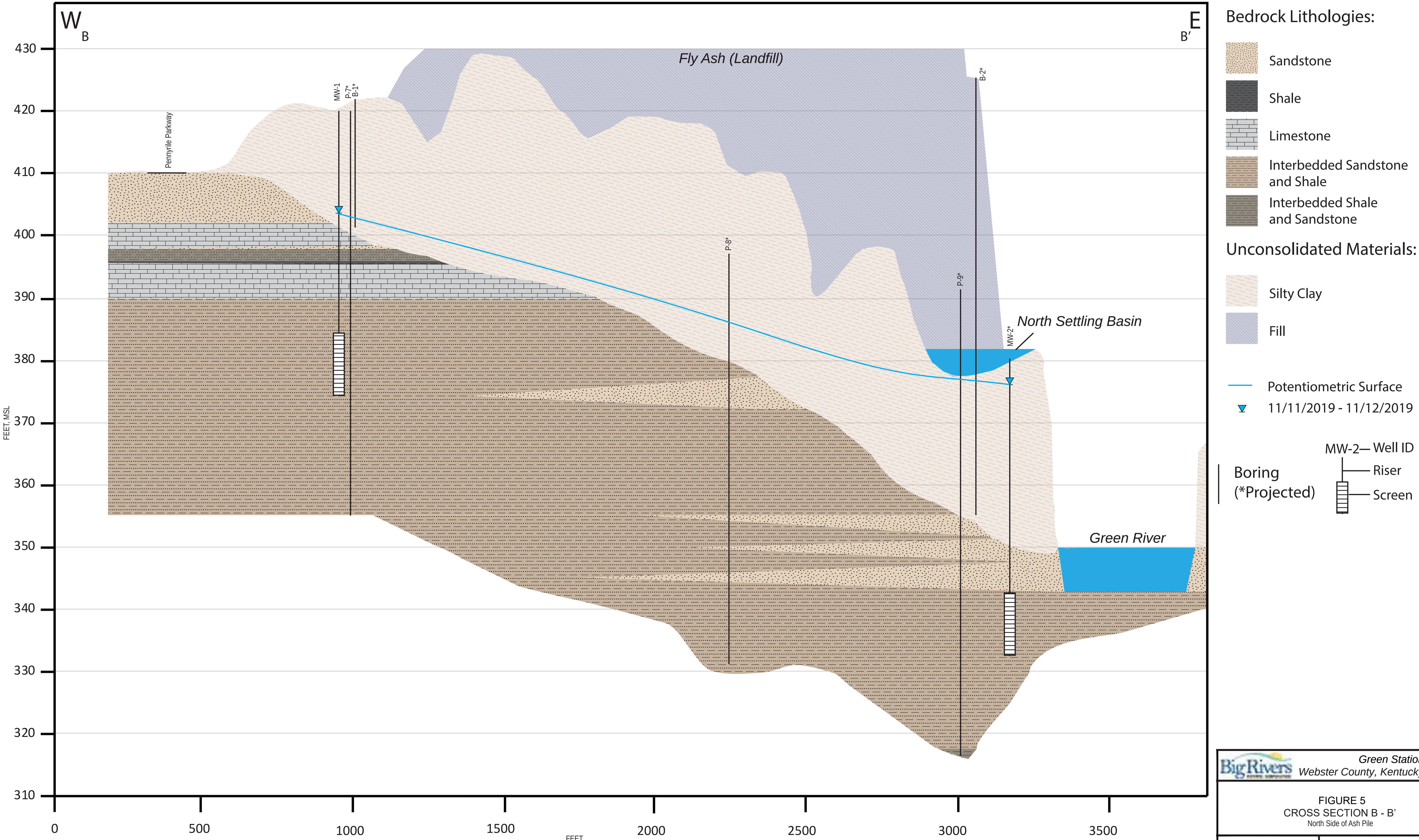



Big Rivers

*Green Station*
*Webster County, Kentucky*

FIGURE 4
CROSS SECTION A - A'
East (River) Side of Ash Pile

| | |
|---|---|
| DATE: 05/01/2020 | SCALE: AS SHOWN |
| CREATED BY: ALY | JOB NO. 60619283 |

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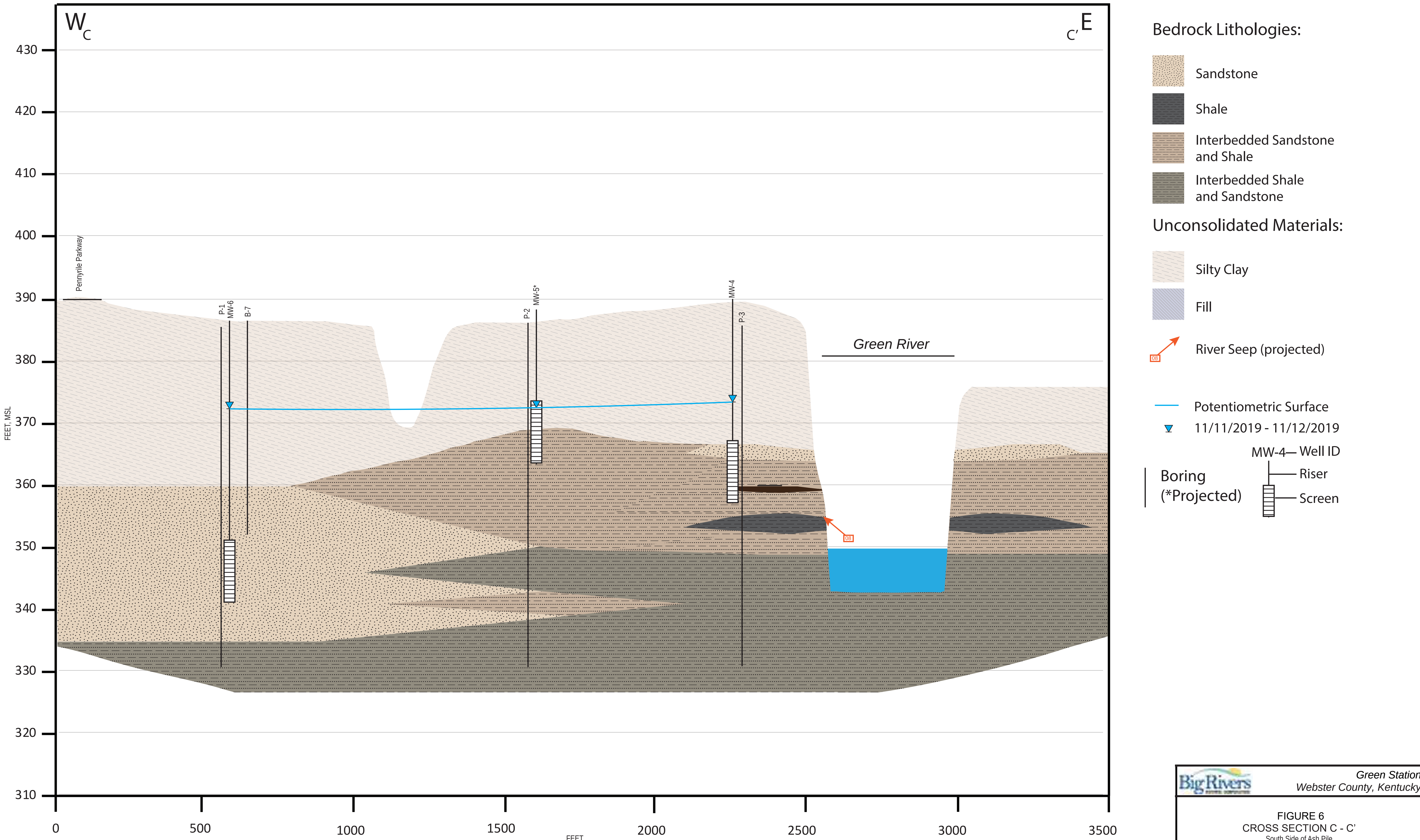
Green Station
Webster County, Kentucky

FIGURE 5
CROSS SECTION B - B'
North Side of Ash Pile

| | |
|---|---|
| DATE: 05/01/2020 | SCALE: AS SHOWN |
| CREATED BY: ALY | JOB NO. 60619283 |

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*Green Station*
*Webster County, Kentucky*

FIGURE 6
CROSS SECTION C - C'
South Side of Ash Pile

| | |
|---|---|
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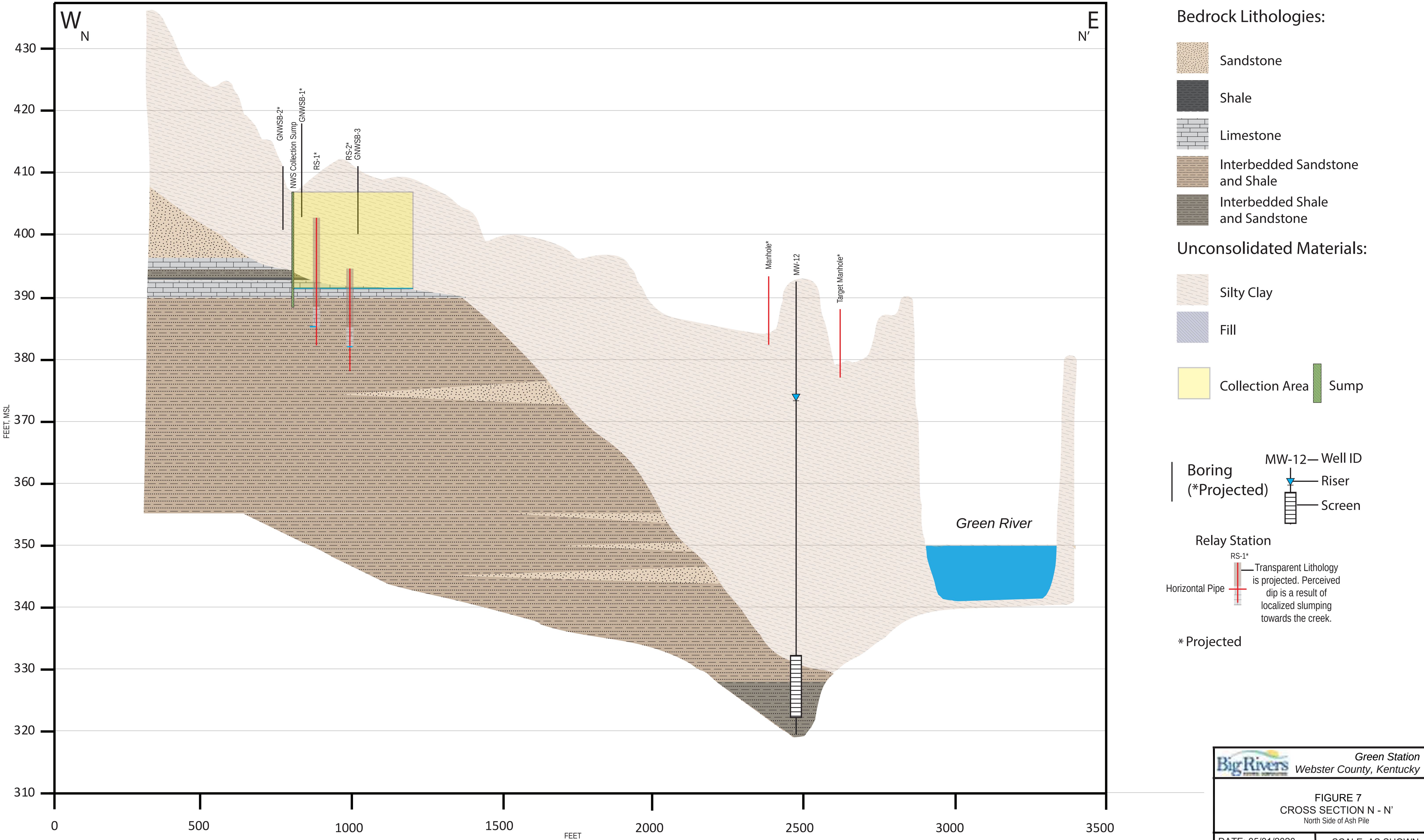
| CREATED BY: ALY | JOB NO. 60619283 |

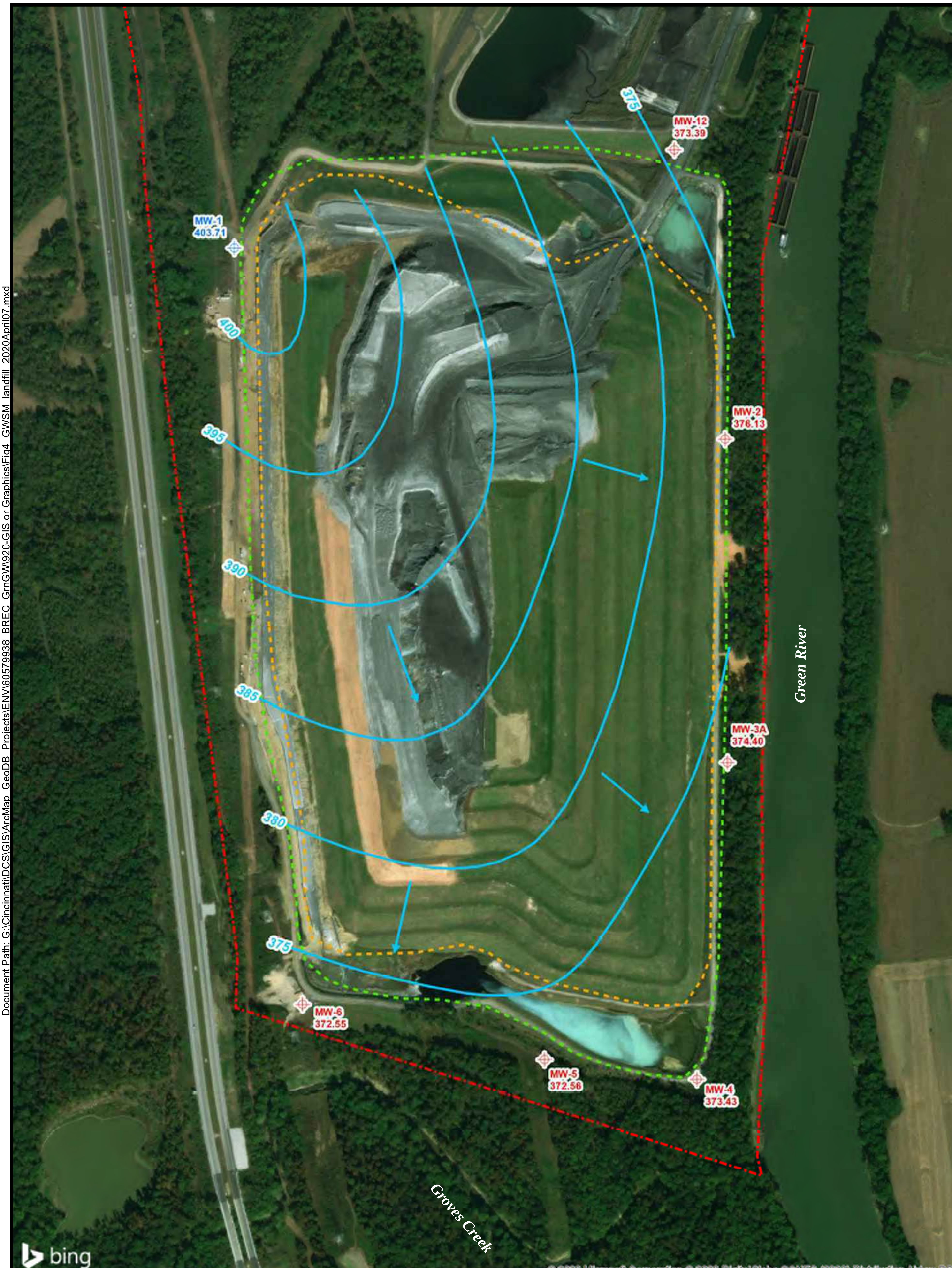



Big Rivers

*Green Station*
*Webster County, Kentucky*

FIGURE 7
CROSS SECTION N - N'
North Side of Ash Pile

| | |
|---|---|
| DATE: 05/01/2020 | SCALE: AS SHOWN |
| CREATED BY: ALY | JOB NO. 60619283 |




**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 8
POTENTIOMETRIC SURFACE MAP
APRIL 7, 2020

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

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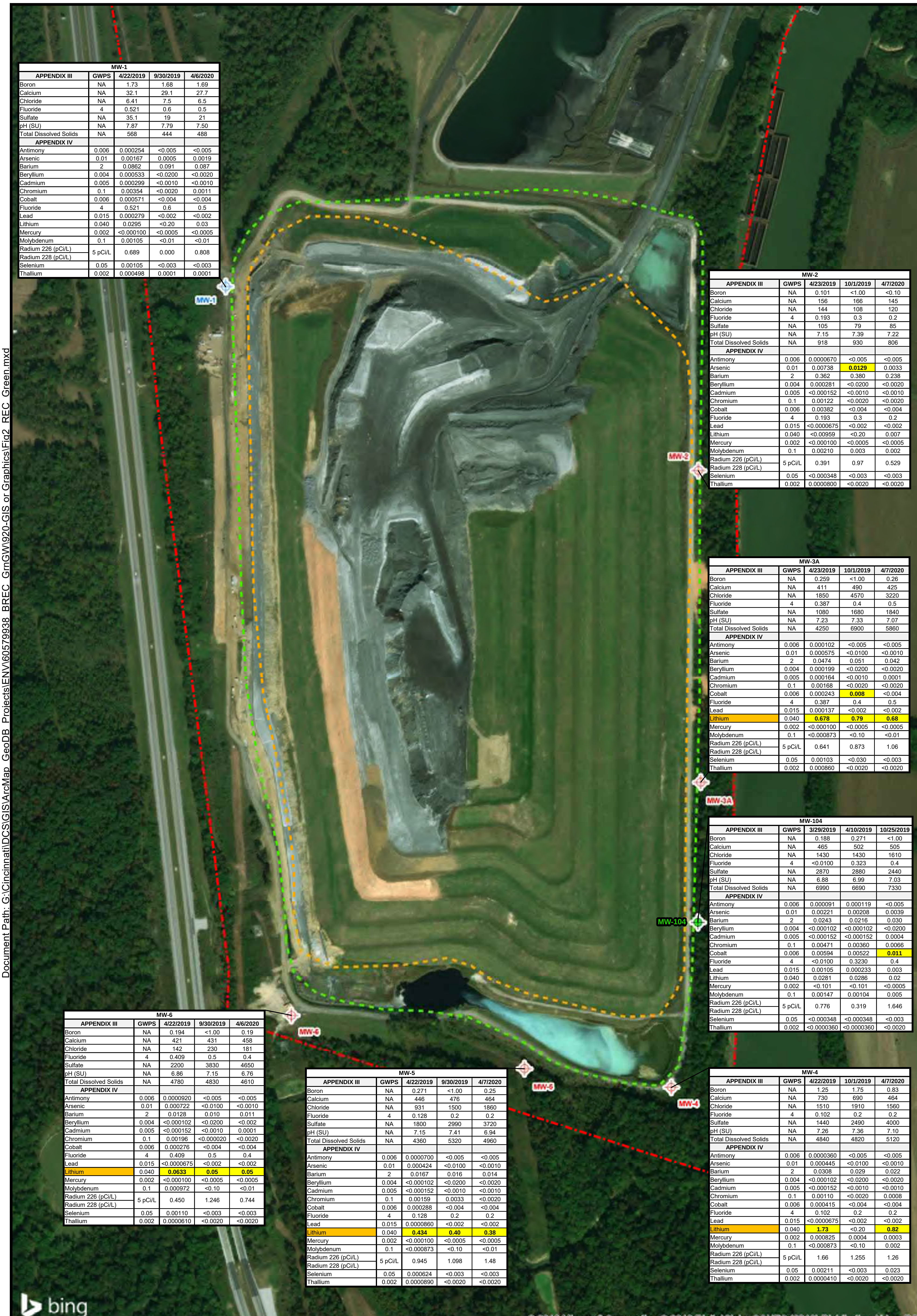


| MW-1 | | | | |
|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **4/22/2019** | **9/30/2019** | **4/6/2020** |
| Boron | NA | 1.73 | 1.68 | 1.69 |
| Calcium | NA | 32.1 | 29.1 | 27.7 |
| Chloride | NA | 6.41 | 7.5 | 6.5 |
| Fluoride | 4 | 0.521 | 0.6 | 0.5 |
| Sulfate | NA | 35.1 | 19 | 21 |
| 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) | 5 pCi/L | 0.689 | 0.000 | 0.808 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 0.391 | 0.97 | 0.529 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 0.641 | 0.873 | 1.06 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 0.776 | 0.319 | 1.646 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 0.450 | 1.246 | 0.744 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 0.945 | 1.098 | 1.48 |
| Radium 228 (pCi/L) | | | | |
| 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) | 5 pCi/L | 1.66 | 1.255 | 1.26 |
| Radium 228 (pCi/L) | | | | |
| Selenium | 0.05 | 0.00211 | <0.003 | 0.023 |
| Thallium | 0.002 | 0.0000410 | <0.0020 | <0.0020 |

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**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

N

0 400 800
Feet

Big Rivers

*Green Landfill*
*Webster County, Kentucky*

FIGURE 9.
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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**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

N

Big Rivers ELECTRIC CORPORATION

*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

# TABLE 1

CCR ANALYTICAL SUMMARY
RIVER SEEP AND RIVER SAMPLE EVALUATION

JULY 2018

BIG RIVERS ELECTRIC CORPORATION
GREEN STATION LANDFILL
WEBSTER COUNTY, KENTUCKY

| Field Parameters | PRIMARY MCL and CCR LIMITS | Water Quality Criteria (mg/L) | | | | River Seep-14-71318 | River Seep-12-71318 | RiverSeep-16-71318 | River 01A 71218 | River 01B 71218 | RiverSeep-08-71218 | RiverSeep-07-71218 | River 02A 71218 | River 02B 71218 | RiverSeep-05-71218 | River 03A 71218 | River 03B 71218 | River 04A 71218 | River 04B 71218 | River-Seep-04-71218 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Human Health | | Warm Water Aquatic Habitat | | | | | | | | | | | | | | | | |
| | | Domestic Water Supply Source | Fish | Acute | Chronic | Lat 37.661126 Long -87.4894 | Lat 37.61732 Long -87.4936 | Lat 37.62167 Long -87.4967 | Lat 37.64610 Long -87.5059 | Lat 37.64610 Long -87.5059 | Lat 37.62860 Long -87.5003 | Lat 37.63299 Long -87.5003 | Lat 37.63303 Long -87.5002 | Lat 37.63303 Long -87.5002 | Lat 37.63433 Long -87.5003 | Lat 37.63433 Long -87.5002 | Lat 37.63433 Long -87.5002 | Lat 37.63789 Long -87.5004 | Lat 37.63789 Long -87.5004 | Lat 37.64122 Long -87.4997 |
| pH (Field Measurement) SU | NA | | | | | 7.54 | 7.37 | 7.46 | 7.94 | 7.94 | 7.09 | 7.27 | 7.91 | 7.91 | 6.92 | 7.94 | 7.94 | 7.86 | 7.86 | 5.13 |
| pH (Lab Measurement) SU | NA | | | | | 8.14 | 8.00 | 8.40 | 7.64 | 7.62 | 8.16 | 8.01 | 7.45 | 7.50 | 7.95 | 7.50 | 7.51 | 7.52 | 7.53 | 5.26 |
| Conductivity (µmhos/cm) | NA | | | | | 1207 | 226.2 | 654 | 268 | 268 | 7674 | 7715 | 267.7 | 267.7 | 6174 | 262.2 | 262.2 | 265.1 | 265.1 | 2545 |
| Temperature (°F) | NA | | | | | 88.34 | 84.0 | 91.58 | 82.9 | 82.9 | 70.52 | 79.7 | 84.2 | 84.2 | 94.28 | 84.2 | 84.2 | 82.6 | 82.6 | 71.6 |
| Oxidation-Reduction Potential (m | NA | | | | | -92 | -98 | -48 | 131 | 131 | 29 | -123 | 98 | 98 | -137 | 133 | 133 | 133 | 133 | 125 |
| **APPENDIX III CONSTITUENTS** | | | | | | | | | | | | | | | | | | | | |
| Boron | NA | | | | | 0.0694 J | 0.0379 J | 0.0321 J | 0.0281 J | 0.0252 J | 0.510 J | 1.46 | 0.0323 J | 0.0322 J | 0.853 J | 0.0251 J | 0.0235 J | 0.0229 J | 0.0234 J | 2.19 |
| Calcium | NA | | | | | 171 | 21.1 | 93.8 | 31.8 | 33.2 | 801 | 1120 | 32.8 | 35.8 | 916 | 34.8 | 32.6 | 32.9 | 34.5 | 460 |
| Chloride | NA | 250 | - | 1200 | 600 | 22.7 | 32.7 | 23.2 | 4.58 B | 4.52 B | 2040 | 1990 | 6.75 B | 6.69 B | 1670 | 5.33 B | 5.59 B | 4.83 B | 4.75 B | 189 |
| Fluoride | 4 mg/L | 4 | - | - | - | 0.144 J | 0.0803 J | 0.177 J | 0.111 J | 0.105 J | 0.0915 J | 0.102 J | 0.0958 J | 0.0979 J | 0.0795 J | 0.100 J | 0.0954 J | 0.0948 J | 0.0945 J | 0.239 J F1 |
| Sulfate | NA | 250 | - | - | - | 159 B | 16.1 B | 26.5 B | 28.5 | 28.3 | 1440 B | 1480 B | 30.6 | 30.1 | 1170 B | 28.8 | 28.9 | 28.6 | 28.6 | 1310 B |
| Total Dissolved Solids | NA | 250 | - | - | - | 790 | 157 | 504 | 169 | 161 | 5310 | 6080 | 173 | 170 | 5140 | 175 | 170 | 174 | 156 | 2130 |
| **APPENDIX IV CONSTITUENTS** | | | | | | | | | | | | | | | | | | | | |
| Antimony | 0.006 mg/L | 0.0056 | 0.64 | - | - | 0.000312 J | 0.000499 J | 0.000270 J | 0.000591 JB | 0.000476 JB | 0.00141 J | ND | 0.00276 B | 0.00106 JB | 0.000366 J | 0.000571 JB | 0.000514 JB | 0.000504 JB | 0.000360 JB | 0.000200 J |
| Arsenic | 0.01 mg/L | 0.01 | - | 0.340 | 0.150 | 0.0173 | 0.00467 J | 0.0247 | 0.00124 J | 0.00137 J | 0.000404 J | 0.00182 J | 0.00131 J | 0.00135 J | 0.0192 | 0.00126 J | 0.00131 J | 0.00118 J | 0.00109 J | 0.00188 J |
| Barium | 2 mg/L | 1 | - | - | - | 0.242 | 0.0757 J | 0.190 J | 0.0330 J | 0.0374 J | 0.0443 J | 0.0605 J | 0.0350 J | 0.0396 J | 0.718 | 0.0366 J | 0.0362 J | 0.0382 J | 0.0402 J | 0.0384 J |
| Beryllium | 0.004 mg/L | 0.004 | - | - | - | 0.000497 J | 0.000145 J | 0.000211 J | ND | ND | ND | ND | ND | ND | 0.000545 J | ND | ND | ND | ND | 0.00372 |
| Cadmium | 0.005 mg/L | 0.005 | - | 0.00235 | 0.00029 | 0.000312 J | 0.000183 J | 0.000196 J | ND | ND | ND | ND | ND | ND | 0.000563 J | ND | ND | ND | ND | 0.00307 |
| Chromium | 0.1 mg/L | 0.1 | - | - | - | 0.00969 | 0.00200 J | 0.00383 | 0.000676 J | 0.00143 J | 0.000560 J | 0.000340 J | 0.00111 J | 0.00155 J | 0.0124 | 0.00112 J | 0.00119 J | 0.00134 J | 0.00105 J | 0.00386 |
| Cobalt | 0.006 mg/L | | | | | 0.0125 | 0.00581 | 0.00613 | 0.000401 J | 0.000623 J | 0.000691 J | 0.0218 | 0.000730 J | 0.000937 J | 0.0327 | 0.000934 J | 0.000800 J | 0.000841 J | 0.000738 J | 0.0447 |
| Fluoride | 4 mg/L | 4 | - | - | - | 0.144 J | 0.0803 J | 0.177 J | 0.111 J | 0.105 J | 0.0915 J | 0.102 J | 0.0958 J | 0.0979 J | 0.0795 J | 0.100 J | 0.0954 J | 0.0948 J | 0.0945 J | 0.239 J F1 |
| Lead | 0.015 mg/L | 0.015 | - | 0.092 | 0.0036 | 0.0109 | 0.00221 J | 0.00521 | 0.000994 JB | 0.00600 B | 0.000769 J | 0.000523 J | 0.00125 JB | 0.00199 JB | 0.0104 | 0.00115 JB | 0.00166 JB | 0.00141 JB | 0.00147 JB | 0.00507 |
| Lithium | 0.040 mg/L | | | | | 0.0126 J | ND | ND | ND | ND | 1.80 | 0.772 | ND | ND | 0.340 | ND | ND | ND | ND | 0.0209 J |
| Mercury | 0.002 mg/L | 0.002 | 0.000051 | 0.0014 | 0.00077 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Molybdenum | 0.1 mg/L | | | | | 0.00550 J | 0.000948 J | 0.00878 J | 0.00217 J | 0.00130 J | 0.00296 J | 0.00219 J | 0.00222 J | 0.00145 J | 0.00442 J | 0.00105 J | 0.00103 J | 0.00101 J | 0.000981 J | ND |
| Radium 226<br>Radium 228 | 5 pCi/L | 5 pCi/L | | | | NS | 1.17 | NS | 0.417 | 0.249 U | 1.31 | 1.4 | 0.554 | 0.735 | 7.64 | 0.404 U | 0.391 U | 0.544 | 0.423 U | 1.48 |
| Selenium | 0.05 mg/L | 0.17 | 4.2 | - | 0.005 | 0.000582 J | ND | 0.000906 J | ND | ND F2 | ND | ND | 0.000423 J | 0.000636 J | 0.00121 J | ND | ND | 0.000402 J | ND | 0.00216 J |
| Thallium | 0.002 mg/L | 0.00024 | 0.00047 | - | - | 0.000126 J | ND | ND | 0.0000500 J | ND | ND | ND | ND | ND | 0.000164 J | ND | ND | ND | ND | ND |
| **IONIC CONSTITUENTS** | | | | | | | | | | | | | | | | | | | | |
| Total Alkalinity | NA | | | | | 443 | 38.2 | 393 | 85.6 | 85.6 | 174 | 87.7 | 85.7 | 85.8 | 229 | 86.1 | 86.4 | 80.9 | 85.8 | ND |
| Hardness (as mg/L of CaCO3)** | NA | | | | | 578 | 74 | 318 | 106 | 110 | 3198 | 3010 | 108 | 117 | 2608 | 115 | 108 | 109 | 114 | 1411 |
| Magnesium | NA | | | | | 36.6 | 5.20 | 20.3 | 6.41 | 6.62 | 291 | 51.8 | 6.32 | 6.76 | 77.8 | 6.87 | 6.41 | 6.45 | 6.73 | 63.6 |
| Potassium | NA | | | | | 4.96 | 2.37 | 4.85 | 2.68 | 2.91 | 125 | 262 | 3.01 | 3.65 | 285 | 3.06 | 2.87 | 2.85 | 2.95 | 9.51 |
| Sodium | NA | | | | | 18.5 | 5.52 | 26.7 | 3.79 | 3.95 | 274 | 277 | 3.98 | 4.63 | 285 | 4.64 | 4.01 | 3.87 | 4.02 | 42.1 |

*All results listed in milligrams per liter (mg/L) unless otherwise noted by the Maximum Contaminant Level (MCL)
NA = Not available
pCi/L = picoCuries per Liter
SU = Standards units
µmhos/cm = microSiems per centimeter
°F = Degrees Fahrenheit
mV = millivolts
ND = Not detected above the 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.
F1 = MS and/or MSD Recovery is outside acceptance limits.
NM = Not measured
U = Result is less than the sample detection limit

Note: River "A" samples collected from surface
River "B" samples collected <1 foot above river bed

** The water hardness is using American degree equivalent to mg/L.
Water hardness(mg/L)=Ca(mg/L)×2.497 ＋ Mg(mg/L)×4.118

| Constituent | KY Acute Warm Water Habitat Equation | Hardness ($mg/L\ CaCO_3$) 50 Criterion (ug/L) | Hardness** ($mg/L\ CaCO_3$) 110 Criterion (ug/L) | | |
|---|---|---|---|---|---|
| Cadmium | Criterion = e(1.0166 (ln Hard*)-3.924) | 1.05 | 2.35 | | |
| Lead | Criterion = e(1.273 (ln Hard*)-1.460) | 34 | 92 | | |

| Constituent | KY Chronic Warm Water Habitat Equation | Hardness ($mg/L\ CaCO_3$) 50 Criterion (ug/L) | Hardness** ($mg/L\ CaCO_3$) 110 Criterion (ug/L) | | |
|---|---|---|---|---|---|
| Cadmium | Criterion = e(0.7409 (ln Hard*)-4.719) | 0.16 | 0.29 | | |
| Lead | Criterion = e(1.273 (ln Hard*)-4.705) | 1.3 | 3.6 | | |

*Hard = Hardness as $mg/L\ CaCO_3$ **Average hardness concentration from collected River Samples (7/12/18)


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**Legend**

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

0 1,450 2,900
Feet

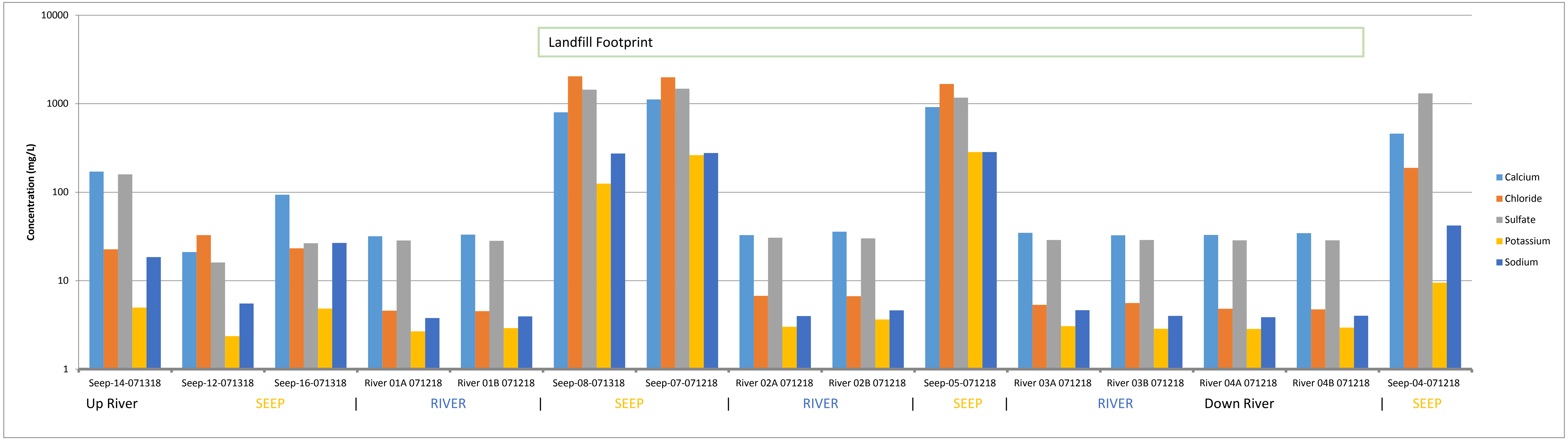
N

Big Rivers

*Green Station Landfill*
*Webster County, Kentucky*

FIGURE 1
RIVER AND SEEP
SAMPLING LOCATIONS

| | |
|---|---|
| DATE: 9/6/2018 | SCALE: 1IN = 1800 FEET |
| CREATED BY: MRH | |
| JOB NO. 60579938 | |



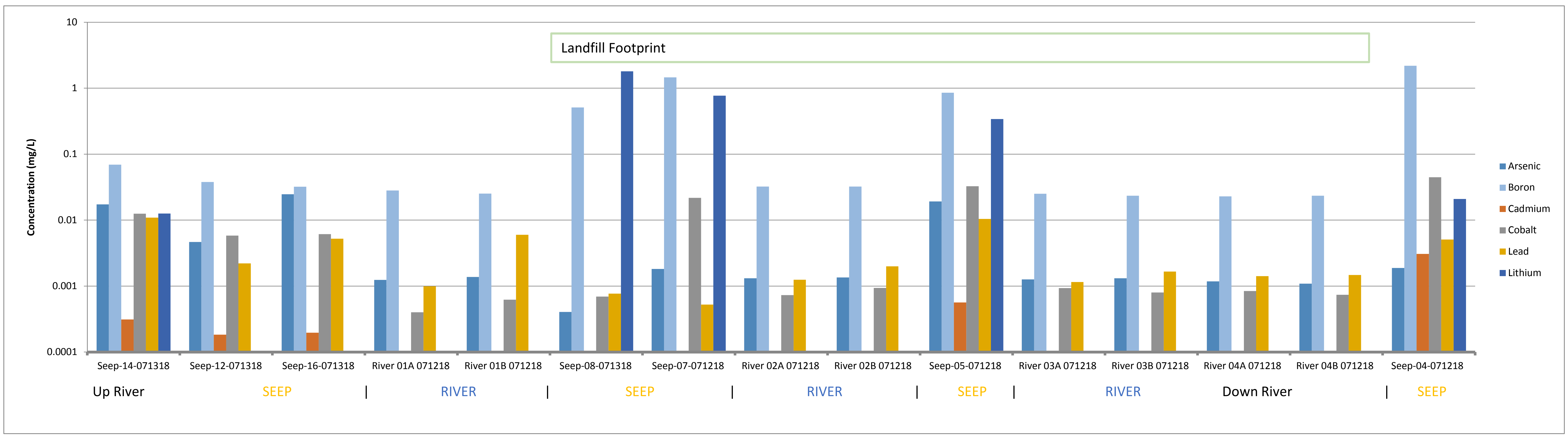




FIGURE 2

CCR ANALYTICAL SUMMARY - GREEN STATION LANDFILL

RIVER SEEP AND RIVER SAMPLE EVALUATION, JULY 2018

8/30/2018

# Appendix B
# Green Landfill Analytical Summary Tables

# GREEN LANDFILL ANALYTICAL SUMMARY TABLES

**GREEN LANDFILL - CCR ANALYTICAL SUMMARY**
**MW-1**

| APPENDIX III CONSTITUENTS | Detection Limit | GWPS | DATE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 | | | | | | | | | | | | | | | | | | Assessment | | Re-Sampling | | Assessment | | | | | |
| 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 | | 28.1 | | 27.1 | | 29.9 | B | 26.4 | | | | 26.5 | | 28.5 | B | 32.1 | | 29.1 | D2 |
| Chloride | 3 | | 9.03 | JB | 0.501 | JB | 6.60 | B | 6.02 | B | 5.56 | 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 | | 7.87 | | 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 | J | NA | | 0.000254 | JB | 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 | J | ND | JB | 0.00167 | JB | 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 | J | | | 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 | | NA | | 0.000533 | J | ND | D2 U |
| Cadmium | 0.001 | 0.005 mg/L | ND | | ND | | ND | | ND | | ND | | ND | | ND | | ND | | | | ND | | ND | | NA | | 0.000299 | J | ND | VI U |
| Chromimum | 0.003 | 0.1 mg/L | ND | | ND | J | ND | | ND | | ND | | ND | | ND | | ND | J | | | 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 | 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 | J | ND | JB | 0.521 | J | 0.6 | |
| Lead | 0.005 | 0.015 mg/L | ND | J | ND | J | ND | J | ND | | ND | | ND | | ND | | 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 | 0.0298 | 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 | V1 U |
| Molybdenum | 0.01 | 0.1 mg/L | ND | | ND | J | ND | J | ND | J | ND | J | ND | J | ND | J | ND | | | | ND | J | ND | J | NA | | 0.00105 | J | ND | U |
| 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 / 0.733 | |
| 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 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | | | Baseline Events | | | | | | | | | Assessment | Re-Sampling | Assessment | | |
| Boron | 0.08 | | ND J | ND J | ND J | ND J | ND JB | ND J | 0.113 JB | ND JB | ND J | | ND J | 0.0630 JB | 0.101 JB | ND D2 U |
| Calcium | 0.5 | | 119 | 116 B | 140 | 140 B | 126 | 152 | 154 | 121 | 150 | | 155 | 165 B | 156 | 166 D1 |
| Chloride | 3 | | 126 B | 125 B | 129 B | 133 | 142 B | 129 B | 145 B | 136 B | 129 B | | 154 B | 159 B | 144 | 108 D |
| Fluoride | 1 | | ND J | ND | ND J | ND JB F1 | ND J | ND JB | ND JB | ND JB F1 | ND J | | ND J | 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 | | 107 | 108 B | 105 | 79.0 D |
| 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 B | ND JB | | ND JB | ND J | NA | 0.0000670 JB | ND V1 U |
| Arsenic | 0.005 | 0.01 mg/L | 0.00703 J | 0.00633 | 0.0110 | 0.0159 | 0.0462 | 0.00755 | 0.0381 | 0.00527 | | 0.0327 B | 0.0119 | 0.0211 B | 0.00738 B | 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 | | 0.369 | 0.323 | 0.367 | 0.362 | 0.380 D2 |
| Beryllium | 0.002 | 0.004 mg/L | ND | ND | ND | ND | ND | ND | ND | ND | | ND | ND | NA | 0.000281 J | ND D2 U |
| Cadmium | 0.001 | 0.005 mg/L | ND J | ND | ND | ND | ND | ND | ND | ND | | ND | ND | NA | ND | ND V1 U |
| Chromimum | 0.003 | 0.1 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND | | ND JB | ND | NA | 0.00122 JB | ND D2 U |
| Cobalt | 0.005 | 0.006 mg/L | ND J | ND J | ND J | ND J | ND J | ND J | ND JB | ND J | | ND JB | ND J | NA | 0.00382 J | ND D2 U |
| Fluoride | 1 | 4 mg/L | ND J | ND | ND J | ND JB F1 | ND J | ND JB | ND JB | ND JB F1 | | ND J | ND J | ND JB | 0.193 J | 0.3 |
| Lead | 0.005 | 0.015 mg/L | ND | ND | ND | ND | ND | ND | ND | ND | | ND | ND J | NA | ND | ND V1 U |
| Lithium | 0.05 | 0.040 mg/L | ND J | ND | ND | ND | ND J | ND J | ND JB | ND | | ND | ND | ND | ND | ND D2 VI U |
| Mercury | 0.0002 | 0.002 mg/L | 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 JB | ND JB | | ND J | ND J | NA | 0.00210 J | 0.003 J |
| Radium 226 | 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 |
| Radium 228 | | | | | | | | | | | | | | | | 0.834 |
| Selenium | 0.01 | 0.05 mg/L | ND | ND | ND | ND JB | ND | ND | ND JB | ND | | ND | ND | NA | ND | ND U |
| Thallium | 0.001 | 0.002 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND | | ND | ND | NA | 0.0000800 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.
F1 = MS and/or MSD Recovery is outside acceptance limits.
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-3A**

| APPENDIX III CONSTITUENTS | Detection Limit | GWPS | DATE 3/26/2016 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Baseline Events | | | | | | | | | Assessment | Re-Sampling | Assessment | | |
| 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 | 438 B | 408 | | 469 | 447 B | 411 | 490 D1 |
| Chloride | 3 | | 2630 HB | 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 | 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 | 6.95 | 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 | 0.006 mg/L | ND | ND J | ND JB | ND JB | ND | ND JB | ND JB | ND JB | | ND JB | ND | NA | 0.000102 JB | ND V1 U |
| Arsenic | 0.005 | 0.01 mg/L | ND | 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 | ND J | ND J | ND | ND | | ND J | ND J | NA | 0.000164 J | ND V1 U |
| Chromimum | 0.003 | 0.1 mg/L | ND | 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 JB | ND J | ND JB | ND | 3.16 | | 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 | ND J | ND J | | ND | ND J | NA | 0.000137 J | ND V1 U |
| Lithium | 0.05 | 0.040 mg/L | 0.669 | 0.516 | 0.648 | 0.677 | 0.689 | 0.746 | 0.767 | 0.762 | | 0.699 | 0.790 | 0.766 | 0.678 | 0.79 D1 |
| Mercury | 0.0002 | 0.002 mg/L | 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 | ND | ND | ND | ND | ND | | ND | ND | NA | ND | ND D2 U |
| Radium 226 | 1 | 5 pCi/L | 1.38 | 0.386 | 0.472 | 1.15 | 1.15 | 0.923 | 1.53 | 1.03 | | 1.18 | 1.43 | 1.21 | 0.641 | 0.139 |
| Radium 228 | | | | | | | | | | | | | | | | 0.734 |
| Selenium | 0.01 | 0.05 mg/L | ND | ND | ND J | ND JB | ND | ND | ND | ND | | ND J | ND | NA | 0.00103 J | ND D2 U |
| Thallium | 0.001 | 0.002 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND J | | ND | ND | NA | 0.000860 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-4**

| APPENDIX III CONSTITUENTS | Detection Limit | GWPS | DATE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3/29/2016 | 5/23/2016 | 8/18/2016 | 10/26/2016 | 2/1/2017 | 5/2/2017 | 8/8/2017 | 9/7/2017 | 10/6/2017 | 6/5/2018 | 7/11/2018 | 9/28/2018 | 4/22/2019 | 10/1/2019 |
| | | | Baseline Events | | | | | | | | | Assessment | Re-Sampling | Assessment | | |
| 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 | 690 D1 |
| Chloride | 3 | | 1450 B | 939 B | 952 B | 1000 B | 1420 B | 1320 B | 1360 B | 1880 B | 1730 B | | 1430 B | 1310 B | 1510 | 1910 D |
| Fluoride | 1 | | ND J | ND | ND J | ND JB | ND J | 1.06 B | ND | ND JB | ND J | | ND J | ND JB | 0.102 J | 0.2 |
| Sulfate | 5 | | 1830 | 1640 | 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 | 6.64 | 6.93 | 6.86 | 6.58 | 8.06 | 7.26 | 7.36 H3 |
| Total Dissolved Solids | 10 | | 3700 | 4250 | 3440 | 3250 | 4420 | 4550 | 4890 | 4700 H | 6220 | | 4880 | 5170 | 4840 B | 4820 H1 |
| **APPENDIX IV CONSTITUENTS** | | | | | | | | | | | | | | | | |
| Antimony | 0.002 | 0.006 mg/L | ND | ND J | ND JB | ND | ND | ND JB | ND JB | ND JB | | ND JB | ND | NA | 0.0000360 JB | ND V1 U |
| Arsenic | 0.005 | 0.01 mg/L | ND | ND J | ND J | ND | 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 J | ND JB | ND J | ND J | ND J | ND JB | | ND J | ND J | ND J | 0.0308 JB | 0.029 D2 J |
| Beryllium | 0.002 | 0.004 mg/L | ND | 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 | ND | NA | ND | ND V1 U |
| Chromimum | 0.003 | 0.1 mg/L | ND | ND J | 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 J | ND | ND | ND | ND | ND | ND | | ND JB | ND J | NA | 0.000415 J | ND U |
| Fluoride | 1 | 4 mg/L | ND | 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 | 0.015 mg/L | ND J | ND J | ND | ND | ND | ND | ND | ND | | ND | ND J | NA | ND | ND V1 U |
| Lithium | 0.05 | 0.040 mg/L | 1.39 | 0.838 | 1.13 | 1.25 | 1.35 | 1.59 | 1.77 | 1.66 | | 1.81 | 1.91 | 1.81 | 1.73 | ND D2 V1 U |
| Mercury | 0.0002 | 0.002 mg/L | 0.00027 | 0.000224 | ND J | 0.000248 | 0.000302 | 0.000717 | 0.000825 | 0.000485 | | 0.000824 | 0.000832 | 0.000680 | 0.000825 | 0.0004 V1 J |
| Molybdenum | 0.01 | 0.1 mg/L | ND J | ND J | ND | ND | ND J | ND | ND | ND | | ND | ND | NA | ND | ND D2 U |
| Radium 226 | 1 | 5 pCi/L | 1.26 | 0.592 | ND | 0.536 | 1.22 | 1.43 | 1.94 | 1.19 | | 1.62 | 2.00 | 1.51 | 1.66 | 0.451 |
| Radium 228 | | | | | | | | | | | | | | | | 0.804 |
| Selenium | 0.01 | 0.05 mg/L | ND J | ND J | ND J | ND | 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 J | ND | ND | ND | ND | | ND | ND | NA | 0.0000410 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-5**

| APPENDIX III CONSTITUENTS | Detection Limit | GWPS | 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 | 7/11/2018 | 9/28/2018 | 4/22/2019 | 9/30/2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Baseline Events | | | | | | | | | Assessment | Re-Sampling | Assessment | | |
| Boron | 0.08 | | 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 | ND D2 U |
| Calcium | 0.5 | | 452 | 189 B | 374 | 399 | 335 | 464 | 423 | 407 B | 383 | | 469 | 441 B | 446 | 476 D1 |
| Chloride | 3 | | 1630 B | 521 | 688 B | 755 B | 734 B | 722 B | 945 B | 779 B | 608 B | | 941 B | 1140 B | 931 | 1500 D |
| Fluoride | 1 | | ND J | ND | ND J | ND | ND J | ND JB | ND | 3.69 | ND J | | ND J | ND JB | 0.128 J | 0.2 |
| Sulfate | 5 | | 1760 HB | 876 | 1780 | 1740 B | 1880 | 1760 B | 2060 B | 1920 | 1600 B | | 1800 | 1890 B | 1800 | 2990 D |
| pH (SU) | 0.10 | | 6.76 | 6.74 | 6.99 | 6.61 | 7.14 | 7.44 | 6.87 | 7.13 | 7.06 | 6.88 | 6.40 | 7.99 | 7.15 | 7.41 H3 |
| Total Dissolved Solids | 10 | | 4210 | 1660 | 3470 | 3610 | 3680 | 4250 | 4130 | 4120 | 4390 | | 4100 | 4540 | 4360 B | 5320 H1 |
| **APPENDIX IV CONSTITUENTS** | | | | | | | | | | | | | | | | |
| Antimony | 0.002 | 0.006 mg/L | ND | ND J | ND JB | ND | ND | ND JB | ND JB | ND JB | | ND JB | ND | NA | 0.0000700 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 JB | | ND JB | ND J | ND JB | 0.000424 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 | 0.016 D2 J |
| Beryllium | 0.002 | 0.004 mg/L | ND | ND | ND J | 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 | ND | NA | ND | ND V1 U |
| Chromimum | 0.003 | 0.1 mg/L | ND | ND J | ND | ND | ND J | ND J | ND | ND J | | 0.00363 B | ND | NA | 0.00159 JB | 0.0033 |
| Cobalt | 0.005 | 0.006 mg/L | ND | ND J | ND J | ND J | ND | ND J | ND | ND J | | ND JB | ND J | NA | 0.000288 J | ND U |
| Fluoride | 1 | 4 mg/L | ND J | ND | ND J | ND | ND J | ND | ND | 3.69 | | ND J | ND J | ND JB | 0.128 J | 0.2 |
| Lead | 0.005 | 0.015 mg/L | ND J | ND J | ND | ND | ND | ND | ND | ND | | ND J | ND J | NA | 0.0000860 J | ND V1 U |
| Lithium | 0.05 | 0.040 mg/L | 0.521 | 0.136 | 0.305 | 0.325 | 0.368 | 0.415 | 0.405 | 0.353 | | 0.459 | 0.481 | 0.425 | 0.434 | 0.40 D1 |
| Mercury | 0.0002 | 0.002 mg/L | ND | ND | ND | ND | ND | ND | 0.00351 | ND | | ND | ND | ND | ND | ND V1 U |
| Molybdenum | 0.01 | 0.1 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND | | ND | ND | NA | ND | ND D2 U |
| Radium 226 | 1 | 5 pCi/L | 1.16 | 0.736 | 0.959 | 0.957 | 0.765 | 0.888 | 1.54 | 0.773 | | 0.862 | 1.42 | 1.37 | 0.945 | 0.368 |
| Radium 228 | | | | | | | | | | | | | | | | 0.730 |
| Selenium | 0.01 | 0.05 mg/L | ND | ND | ND | ND | ND J | ND J | ND | ND | | ND J | ND | NA | 0.000624 J | ND U |
| Thallium | 0.001 | 0.002 mg/L | ND | ND | ND J | ND J | ND | ND J | ND | ND J | | ND J | ND | NA | 0.0000890 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 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | | | Baseline Events | | | | | | | | | Assessment | Re-Sampling | Assessment | | |
| Boron | 0.08 | | 0.156 | 0.137 J | 0.193 J | 0.168 J | 0.173 B | 0.179 J | 0.167 JB | 0.199 J | 0.178 | | 0.155 J | 0.196 JB | 0.194 JB | ND D2 U |
| Calcium | 0.5 | | 467 | 374 B | 373 | 400 | 320 | 415 | 365 | 382 B | 376 | | 386 | 356 B | 421 | 431 D1 |
| Chloride | 3 | | 167 B | 149 B | 136 JB | 150 B | 125 B | 129 B | 128 B | 123 B | 138 B | | 147 B | 142 B | 142 | 230 D |
| Fluoride | 1 | | ND J | ND J | ND J | ND JB | ND J | ND JB | ND | ND J | ND J | | ND J | ND JB | 0.409 J | 0.5 |
| Sulfate | 5 | | 2250 HB | 3340 | 2550 | 2610 B | 2700 | 2600 B | 2820 B | 2490 | 2700 B | | 2120 | 2420 | 2200 | 3830 D |
| 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 | 6.86 | 7.15 H3 |
| Total Dissolved Solids | 10 | | 4060 | 4280 | 4350 | 4470 | 4720 | 4700 | 4830 | 4890 | 4910 | | 4500 | 4820 | 4780 B | 4830 H1 |
| **APPENDIX IV CONSTITUENTS** | | | | | | | | | | | | | | | | |
| Antimony | 0.002 | 0.006 mg/L | ND | ND J | ND JB | ND | ND | ND JB | ND JB | ND JB | | ND JB | ND | NA | 0.0000920 JB | ND V1 U |
| Arsenic | 0.005 | 0.01 mg/L | ND | ND J | ND J | ND J | ND J | ND J | ND J | ND JB | | ND JB | ND J | ND JB | 0.000722 JB | 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 | 0.0128 J | 0.010 D2 J |
| Beryllium | 0.002 | 0.004 mg/L | 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 | NA | ND | ND V1 U |
| Chromimum | 0.003 | 0.1 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND J | | ND JB | ND | NA | 0.00196 JB | ND 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 | 0.000276 J | ND U |
| Fluoride | 1 | 4 mg/L | ND J | ND J | ND J | ND JB | ND J | ND JB | ND | ND J | | ND J | ND J | ND JB | 0.409 J | 0.5 |
| Lead | 0.005 | 0.015 mg/L | ND J | ND J | ND | ND | ND | ND | ND | ND | | ND | ND J | NA | ND | ND V1 U |
| Lithium | 0.05 | 0.040 mg/L | 0.0475 J | 0.0527 | 0.0555 | 0.0524 | 0.0607 | 0.0724 | 0.0589 | 0.0554 | | 0.0650 | 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 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 | NA | 0.000972 J | ND D2 U |
| Radium 226 | 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 |
| Radium 228 | | | | | | | | | | | | | | | | 0.698 |
| Selenium | 0.01 | 0.05 mg/L | ND | ND | ND | ND | ND | ND | ND | ND | | ND J | ND | NA | 0.00110 J | ND U |
| Thallium | 0.001 | 0.002 mg/L | ND | ND J | ND | ND | ND | ND | ND | ND | | ND | ND | NA | 0.0000610 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.
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-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 | | 6990 | | 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
D2 = Sample required dilution due to matrix interference
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 C4. Big Rivers Green Landfill Appendix IV SSI Summary**

| Well | Location | Sb | As | Ba | Be | Cd | Cr | Co | F | Pb | Li | Hg | Mo | Ra-226+228 | Se | Tl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | Upgradient | NP | Np | P | NP | NP | P | P | NP | Pb | P | NP | NP | P | NP | 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**
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# 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

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

Rob Whittington, Project Manager

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

## 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 |

| LabNumber | Measurement | Value |
|---|---|---|
| 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 |

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**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/Acronymns

| | |
|---|---|
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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 |

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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 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

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|---|---|---|---|---|---|---|---|---|---|---|
| **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 | %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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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 | | | |
| **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 |

**Certified Analyses included in this Report**

| Analyte | Certifications |
|---|---|
| ***2510 B-2011 in Water*** | |
| Specific Conductance (Lab) | KY Drinking Water Mdv (00030) |
| ***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) |
| ***5310 C-2011 in Water*** | |
| Total Organic Carbon | KY Drinking Water Mdv (00030) |
| ***HACH 8000 in Water*** | |
| Chemical Oxygen Demand | KY Wastewater Mdv (00030) |
| ***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 | ☑ |

Pace Analytical Services LLC Kentucky
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Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 #**
**0041376**

| Sample ID# | Date (mm/dd/yy) | Collection Time (24 hr) | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-01 A | 4/6/20 | 1305 | 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 :** ✓ | | | | |
| 0041376-01 B | 4/6/20 | 1305 | 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 :** ✓ | | | | |
| 0041376-01 C | 4/6/20 | 1305 | Plastic 1L | 1 | MW1 | g / c | pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 |

**Preservation Check Performed by:** CLH

Field data collected by: Phillip Hill Date (mm/dd/yy) 4/6/20 Time (24 hr) 1305

pH 7.22 Cond ~~(umho)~~ mS/cm 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] | 4/7/20 | 14:43 |
| [signature] | [signature] (1.9°) | 4-7-20 | 1549 |
| | | | |
| | | | |

☐ **PACE- Check here if trip charge applied to associated COC**

**Printed: 3/25/2020 2:51:08PM**

Pace Analytical Services LLC Kentucky
P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 Workorder # **0041376** Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

☐ **PACE- Check here if trip charge applied to associated COC**

**Printed: 3/25/2020 2:51:08PM**

Pace Analytical Services LLC Kentucky
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Phone: (270) 844-6000
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Henderson, KY 42419

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 #** **0041376**

| Sample ID# | Date (mm/dd/yy) | Collection Time (24 hr) | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 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) 1686 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

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Pace Analytical Services LLC Kentucky
P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 # 0041376**

| Sample ID# | Date (mm/dd/yy) | Collection Time (24 hr) | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-02 E | 4/7/20 | 1140 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) **Preservation Check: pH :** ✓ | 1 | MW2 | g / c | Radium 226 (sub) |
| 0041376-02 F | 4/7/20 | 1140 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) **Preservation Check: pH :** ✓ | 1 | MW2 | g / c | Radium 228 (sub) |
| 0041376-02 G | 4/7/20 | 1140 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) **Preservation Check: pH :** ✓ | 1 | MW2 | g / c | Radium 228 (sub) |
| 0041376-02 H | 4/7/20 | 1140 | AG 250mL pH<2 w/H2SO4 **Preservation Check: pH :** ✓ | 1 | MW2 | g / c | TOC |
| 0041376-03 A | 4/7/20 | 1355 | 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:** 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) 16.84 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

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Pace Analytical Services LLC Kentucky
P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 Workorder # **0041376** Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-03 B | 4/7/20 | 1355 | Plastic 500mL pH<2 w/HNO3<br>**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 |
| 0041376-03 C | 4/7/20 | 1355 | Plastic 1L | 1 | MW3A | g / c | pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 |
| 0041376-03 D | 4/7/20 | 1355 | Plastic 500mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | MW3A | g / c | COD TOC |
| 0041376-03 E | 4/7/20 | 1355 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW3A | g / c | Radium 226 (sub) |
| 0041376-03 F | 4/7/20 | 1355 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW3A | 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) 1355

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] | 4/7/20 | 1442 |
| [signature] | [signature] | 4-7-20 | 1549 |
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P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 # 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 | 1355 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW3A | g / c | Radium 228 (sub) |
| 0041376-03 H | 4/7/20 | 1355 | AG 250mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | MW3A | g / c | TOC |
| 0041376-04 A | 4/7/20 | 955 | Plastic 500mL pH<2 w/HNO3<br>**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: Phillip Hill Date (mm/dd/yy) ________ Time (24 hr) ________

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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 #** **0041376**

| Sample ID# | Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-04 B | 4/7/20 | 955 | Plastic 500mL pH<2 w/HNO3<br>**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 |
| 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<br>**Preservation Check: pH :** ✓ | 1 | MW4 | g / c | COD TOC |
| 0041376-04 E | 4/7/20 | 955 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW4 | g / c | Radium 226 (sub) |
| 0041376-04 F | 4/7/20 | 955 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW4 | 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) 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

| Client: Big Rivers Electric Corporation Reid/Green Station | Report To: | Invoice To: |
|---|---|---|
| Project: Green Landfill Semiannual Groundwater | Big Rivers Electric Corporation Reid/Green Station<br>Chad Phillips<br>PO Box 24<br>Henderson, KY 42419 | Big Rivers Electric Corporation Reid/Green Station<br>Chad Phillips<br>PO Box 24<br>Henderson, KY 42419 |
| | Phone: (270) 844-6000<br>PWS ID#:<br>State: KY | PO#:<br>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 # 0041376 Sample ID# | Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-04 G | 4/7/20 | 955 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>Preservation Check: pH : ✓ | 1 | MW4 | g / c | Radium 228 (sub) |
| 0041376-04 H | 4/7/20 | 955 | AG 250mL pH<2 w/H2SO4<br>Preservation Check: pH : ✓ | 1 | MW4 | g / c | TOC |
| 0041376-05 A | 4/7/20 | 1010 | Plastic 500mL pH<2 w/HNO3<br>Preservation Check: pH : ✓ | 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 |

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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 Workorder # 0041376 Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-05 B | 4/7/20 | 1010 | Plastic 500mL pH<2 w/HNO3<br>Preservation Check: pH : ✓ | 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 | 4/7/20 | 1010 | Plastic 1L | 1 | MW5 | g / c | pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 |
| 0041376-05 D | 4/7/20 | 1010 | Plastic 500mL pH<2 w/H2SO4<br>Preservation Check: pH : ✓ | 1 | MW5 | g / c | COD TOC |
| 0041376-05 E | 4/7/20 | 1010 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>Preservation Check: pH : ✓ | 1 | MW5 | g / c | Radium 226 (sub) |
| 0041376-05 F | 4/7/20 | 1010 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>Preservation Check: pH : ✓ | 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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Pace Analytical Services LLC Kentucky
P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

**Please Print Legibly**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

PO#: ______
Quote# ______

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 Workorder # 0041376 Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-05 G | 4/7/20 | 1010 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW5 | g / c | Radium 228 (sub) |
| 0041376-05 H | 4/7/20 | 1010 | AG 250mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | MW5 | g / c | TOC |
| 0041376-06 A | 4/6/20 | 1420 | Plastic 500mL pH<2 w/HNO3<br>**Preservation Check: pH :** ✓ | 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 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] | 4/7/20 | 1447 |
| [signature] | [signature] | 4-7-20 | 1549 |
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Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 Workorder # 0041376 Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-06 B | 4/6/20 | 1420 | Plastic 500mL pH<2 w/HNO3<br>Preservation Check: pH : ✓ | 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 |
| 0041376-06 D | 4/6/20 | 1420 | Plastic 500mL pH<2 w/H2SO4<br>Preservation Check: pH : ✓ | 1 | MW6 | g / c | COD TOC |
| 0041376-06 E | 4/6/20 | 1420 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>Preservation Check: pH : ✓ | 1 | MW6 | g / c | Radium 226 (sub) |
| 0041376-06 F | 4/6/20 | 1420 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>Preservation Check: pH : ✓ | 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 6.36 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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Pace Analytical Services LLC Kentucky
P.O. Box 907
Madisonville, KY 42431

# Chain of Custody

**Scheduled for: 04/01/2020**

**Client: Big Rivers Electric Corporation Reid/Green Station**

**Project: Green Landfill Semiannual Groundwater**

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

Phone: (270) 844-6000
PWS ID#:
State: KY

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

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 Workorder # **0041376** Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-06 G | 4/6/20 | 1420 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | MW6 | g / c | Radium 228 (sub) |
| 0041376-06 H | 4/6/20 | 1420 | AG 250mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | MW6 | g / c | TOC |
| 0041376-07 A | 4/7/20 | 1020 | Plastic 500mL pH<2 w/HNO3<br>**Preservation Check: pH :** ✓ | 1 | 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

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Henderson, KY 42419

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 Workorder # **0041376** Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-07 B | 4/7/20 | 1020 | Plastic 500mL pH<2 w/HNO3<br>Preservation Check: pH : ✓ | 1 | 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 | 4/7/20 | 1020 | Plastic 1L | 1 | DUPLICATE | g / c | pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 |
| 0041376-07 D | 4/7/20 | 1020 | Plastic 500mL pH<2 w/H2SO4<br>Preservation Check: pH : ✓ | 1 | DUPLICATE | g / c | COD TOC |
| 0041376-07 E | 4/7/20 | 1020 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>Preservation Check: pH : ✓ | 1 | DUPLICATE | g / c | Radium 226 (sub) |
| 0041376-07 F | 4/7/20 | 1020 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>Preservation Check: pH : ✓ | 1 | 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
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Henderson, KY 42419

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 Workorder # 0041376 Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-07 G | 4/7/20 | 1020 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) **Preservation Check: pH :** ✓ | 1 | DUPLICATE | g / c | Radium 228 (sub) |
| 0041376-07 H | 4/7/20 | 1020 | AG 250mL pH<2 w/H2SO4 **Preservation Check: pH :** ✓ | 1 | DUPLICATE | g / c | TOC |
| 0041376-08 A | 4/7/20 | 1150 | Plastic 500mL pH<2 w/HNO3 **Preservation Check: pH :** ✓ | 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 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)~~ 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] | 4/7/20 | 1447 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
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Quote# ______

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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 #**
**0041376**

| Sample ID# | Date (mm/dd/yy) | Collection Time (24 hr) | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-08 B | 4/7/20 | 1150 | Plastic 500mL pH<2 w/HNO3<br>**Preservation Check: pH :** ✓ | 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 |
| 0041376-08 C | 4/7/20 | 1150 | Plastic 1L | 1 | FIELD BLANK | g / c | pH (Lab) Conductivity (Lab) TDS Sulfate 9056 Chloride 9056 Fluoride 9056 |
| 0041376-08 D | 4/7/20 | 1150 | Plastic 500mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | FIELD BLANK | g / c | COD TOC |
| 0041376-08 E | 4/7/20 | 1150 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | FIELD BLANK | g / c | Radium 226 (sub) |
| 0041376-08 F | 4/7/20 | 1150 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | FIELD BLANK | 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) 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

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Quote# ____________

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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 Workorder # 0041376 Sample ID# | *required information* Date (mm/dd/yy): | Collection Time (24 hr): | Bottle and Preservative | Containers | Sample Description | Composite | Sample Analysis Requested |
|---|---|---|---|---|---|---|---|
| 0041376-08 G | 4/7/20 | 1150 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub)<br>**Preservation Check: pH :** ✓ | 1 | FIELD BLANK | g / c | Radium 228 (sub) |
| 0041376-08 H | 4/7/20 | 1150 | AG 250mL pH<2 w/H2SO4<br>**Preservation Check: pH :** ✓ | 1 | FIELD BLANK | g / c | TOC |
| [illegible] | [illegible] | [illegible] | [illegible] HNO3<br>**Preservation Check: pH :** ____ | 1 | [illegible] | [illegible] | Be[illegible] 6020 Cadmium Tot [illegible] Tot 6010B Barium Tot 60[illegible] Cobalt Tot [illegible] Boron Tot [illegible] Tot 6020 Antimony [illegible] 6020 Mercu[illegible] 6020 Sodium Tot 6010B |

**Preservation Check Performed by:** CLH

Field data collected by: Philip 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] | 4/7/20 | 1443 |
| [signature] | [signature] | 4-7-20 | 1549 |
| | | | |
| | | | |

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**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

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**

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

## 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

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

# 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 |

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

# 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

Pace Analytical
www.pacelabs.com

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

## 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**

## 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 | |

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

## 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 | |

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

# 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.

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

## 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

**Pace Analytical Services, LLC**
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

# 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.

Chain of Custody

Pace Analytical

Workorder: 41376 Workorder Name: Green Landfill Semiannual Owner Received Date: 4/7/2020 Results Requested By:

| Report To: | Subcontract To: |
|---|---|
| McCoy & McCoy Labs<br>P.O. Box 907<br>Madisonville, KY 42409<br>270-821-7375<br>r.whittington@mccoylabs.com | Pace Analytical Services LLC Greensburg PA<br>1638 Rosey Town Rd Suite 2,3,4<br>Greensburg, PA 15601<br>(724) 850-5615 |

Requested Analysis

WO#: 30358430

30358430

| Item | Sample ID | Sample Type | Collect Date/Time | Lab ID | Matrix | Preserved Containers | EPA 903.1 | EPA 904.0 Radium Sum Calc | LAB USE ONLY |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | ~~Drinking~~ | | | | |
| 2 | 0041376-01 | | 04/06/20 13:05 | IR44-McCoy | Water | | X | X | 001 |
| 3 | 0041376-02 | | 04/07/20 11:40 | IR44-McCoy | Water | | X | X | 002 |
| 4 | 0041376-03 | | 04/07/20 13:55 | IR44-McCoy | Water | | X | X | 003 |
| 5 | 0041376-04 | | 04/07/20 09:55 | IR44-McCoy | Water | | X | X | 004 |
| 6 | 0041376-05 | | 04/07/20 10:10 | IR44-McCoy | Water | | X | X | 005 |
| 7 | 0041376-06 | | 04/06/20 14:20 | IR44-McCoy | Water | | X | X | 006 |
| 8 | 0041376-07 | | 04/07/20 10:20 | IR44-McCoy | Water | | X | X | 007 |
| 9 | 0041376-08 | | 04/07/20 11:50 | IR44-McCoy | Water | | X | X | 008 |
| 10 | | | | | | | | | |

| Transfers | Released By | Date/Time | Reveived By | Date/Time | Comments |
|---|---|---|---|---|---|
| 1 | | | Nicole Russo | 4/10/2020 0915 | |
| 2 | | | | | |
| 3 | | | | | |

| Cooler Temperature on Receipt 4.7 °C | Custody Seal Y or (N) | Received on Ice (Y) or N | Sample Intact (Y) or N |
|---|---|---|---|

***In order to maintain client confidentiality, location/name of the sampling site, sampler's name and signature may not be provided on this COC

This chain of custody is considered complete as is since this information is available in the owner laboratory.

**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 | Received By | Date |
|---|---|---|---|
| [signature] | 04-09-20 | | |
| Released By | Date | Received By | Date |
| | | | |

**SUBCONTRACT ORDER**

**Pace Analytical Services, LLC Kentucky** # 30358430

**0041376**

| 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 |
|---|---|---|---|
| [signature] | 04.09.20 | | |

| Released By | Date | Received By | Date |
|---|---|---|---|
| | | | |

## Sample Custody

By Nancy Yeager

Printed 04/09/2020 09:05

# 30350430

| Lab ID | Container | Cooler | Last Owner | Department | Location | Home Location | Status | Disposition | Custody Date |
|---|---|---|---|---|---|---|---|---|---|
| 0041376-01 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-01 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-02 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-02 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-03 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-03 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-04 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-04 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-05 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-05 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-06 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-06 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-07 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-07 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-08 | Plastic 1L pH<2 w/HNO3 Rad 226 (Sub) | Default Cooler | NDY | Wet Chem | In-Transit | | Batched | Active (Out) | 04/09/2020 09:05 |
| 0041376-08 | Plastic 1L pH<2 w/HNO3 Rad 228 (Sub) | Default Cooler | 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

Pace Analytical | Client Name: McCoy + McCoy | Project # 30358430

Courier: ☑ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other ______

Label BVM
LIMS Login BVM

Tracking #: 1107 3386 1178

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

pH paper Lot# 10D0391

Date and Initials of person examining contents: NMR 4/10/2020

| Comments: | Yes | No | N/A | |
|---|---|---|---|---|
| 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: | | ✓ | | 5. no date + time on labels |
| -Includes date/time/ID  Matrix: WT | | | | |
| 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: | ✓ | | | 10. |
| -Pace Containers Used: | | ✓ | | |
| 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. added 5.0mL $HNO_3$ to each sample |
| All containers meet method preservation requirements. | | ✓ | | Initial when completed NMR / Date/time of preservation 4/10/2020 1610 |
| | | | | Lot # of added preservative DL20-0362 |
| 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: NMR / Date: 4/10/2020 |

**Client Notification/ Resolution:**

Person Contacted: ______ Date/Time: ______ Contacted By: ______

Comments/ Resolution: ______

☐ **A check in this box indicates that additional information has been stored in ereports.**

**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.

J:\QAQC\Master\Document Management\Sample Mgt\Sample Condition Upon Receipt Pittsburgh (C056-9 5April2019)

# 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 Evaluation Criteria under 40 CFR 257.97 | Corrective Measure Alternative Alt 2a | Alt 3 | Alt 4 | Alt 5 | Benefit Analysis |
|---|---|---|---|---|---|---|
| **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) | 1 | 3.5 | 2 | 3.5 | 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 required 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 | 1 | 3 | 2 | 4 | 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 furthers 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 a 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. |
| | **SUBTOTALS** | **6.5** | **15** | **11.5** | **17** | |

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-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) | 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 | 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 itis 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)(ii) | 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)(iii) | 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 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)(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 | 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 furthes 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)(v) | Time until full protection is achieved | 1 | 3 | 2 | 4 | Alt 2a will achieve the established CAO at the end of the Unit operational lifecycle after cap construction, which would hault source loading to groundwater, and further allow unimpacted 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 sourcce material of the South Sediment Basin which will end the source loading to groundwater, as unimpacted 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 unimpacted groundwater flushes through the aquifer. Alt 5 would attain the established CAO for the Unit after removing sourcce material from the South Sediment Basin which will end the source loading to groundwater, as unimpacted 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 | All 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 furthers 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 | All 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**. **Alt 3** incorporates source control measures, and has been scored higher than **Alt 4**. |
| (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 | 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 furthers 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**. **Alt 3** incorporates source control measures, and has been scored higher than **Alt 4**. |
| (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 | All 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

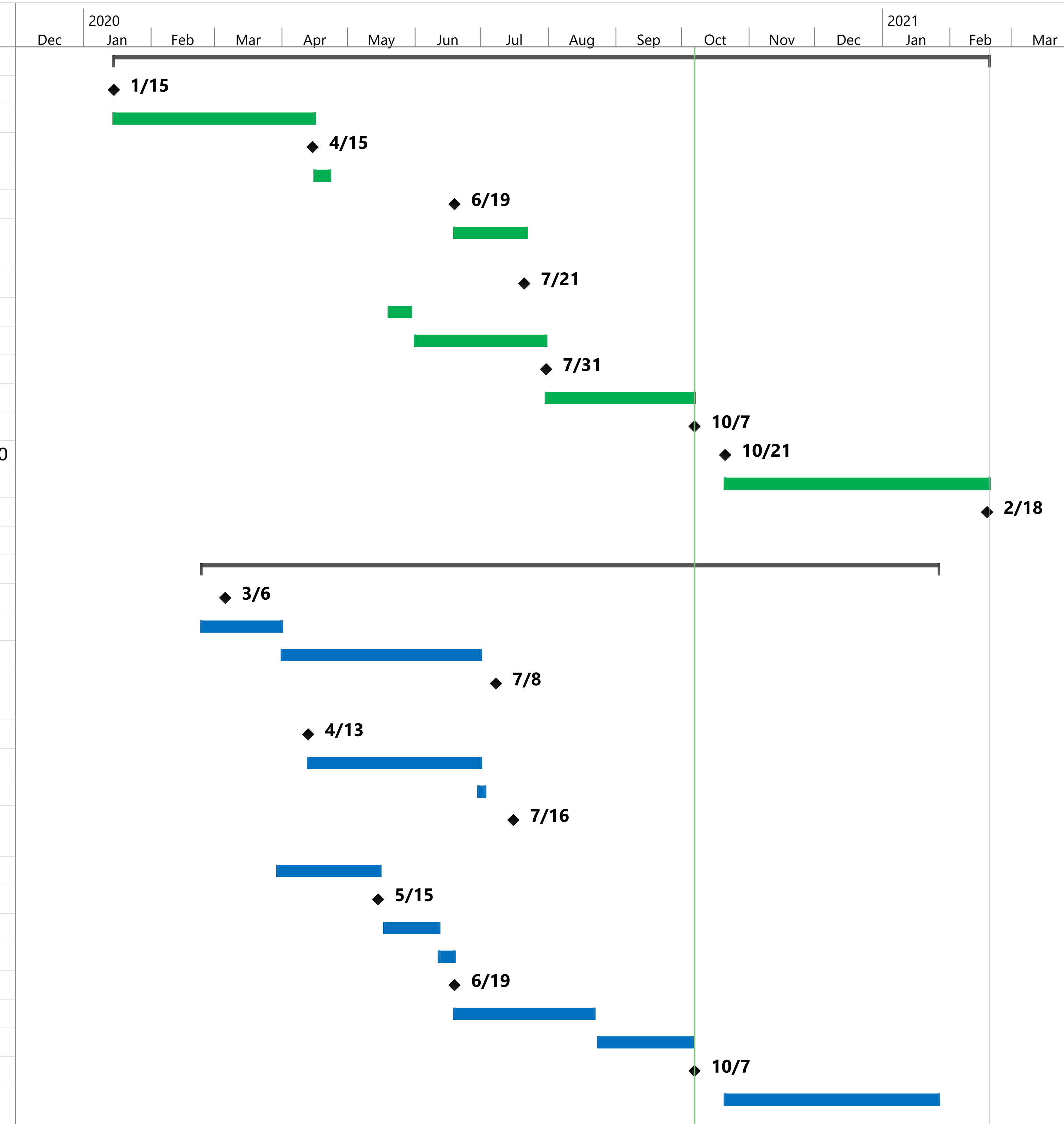
| 40 CFR 257.97 Reference | Corrective Measure Evaluation Criteria under 40 CFR 257.97 | Corrective Measure Alternative Alt 2a | Alt 3 | Alt 4 | Alt 5 | Benefit Analysis |
|---|---|---|---|---|---|---|
| **Modifying Criteria** | | | | | | |
| (c)(4) | The degree to which community concerns are addressed by a potential remedy(s) | | | | | |
| NA (Agreed Order) | State Acceptance [See Notes] | 1 | 3.5 | 3.5 | 2 | **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. |
| (c)(4) | Community Acceptance [See Notes] | 1 | 3.5 | 3.5 | 2 | **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. |
| | **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

| ID | Task Mode | Task Name | Start | Finish |
|---|---|---|---|---|
| 1 | | **Green Landfill - Perimeter Seepage Control Design** | **Wed 1/15/20** | **Thu 2/18/21** |
| 2 | | AEC-000: Purchase Order Received by AECOM | Wed 1/15/20 | Wed 1/15/20 |
| 3 | | AEC-010: Develop 60% Civil Design | Wed 1/15/20 | Wed 4/15/20 |
| 4 | | AEC-40: Submit 60% Draft Civil Design and Specifications | Wed 4/15/20 | Wed 4/15/20 |
| 5 | | CLI-10: Client Review of 60% Civil Design | Thu 4/16/20 | Wed 4/22/20 |
| 6 | | AEC-020: Submit Perimeter Seepage Design to Agency | Fri 6/19/20 | Fri 6/19/20 |
| 7 | | AEC-30: Develop 90% Draft Civil Design and Specifications | Fri 6/19/20 | Tue 7/21/20 |
| 8 | | AEC-40: Submit 90% Draft Civil Design and Specifications | Tue 7/21/20 | Tue 7/21/20 |
| 9 | | CLI-020: Prepare Bid Documents | Wed 5/20/20 | Fri 5/29/20 |
| 10 | | CLI-030: Bid Period | Mon 6/1/20 | Thu 7/30/20 |
| 11 | | CLI-040: Bids Due | Fri 7/31/20 | Fri 7/31/20 |
| 12 | | CLI-050: Negotiate Award | Fri 7/31/20 | Tue 10/6/20 |
| 13 | | CLI-060: Award Contract | Wed 10/7/20 | Wed 10/7/20 |
| 14 | | CLI-070: Construction Start | Wed 10/21/20 | Wed 10/21/20 |
| 15 | | CLI-080: Construction | Wed 10/21/20 | Thu 2/18/21 |
| 16 | | CLI-090: Construction Complete | Thu 2/18/21 | Thu 2/18/21 |
| 17 | | | | |
| 18 | | **Green Landfill - Groundwater Remedy Selection** | **Mon 2/24/20** | **Tue 1/26/21** |
| 19 | | 1: Receive Big Rivers concurrence on tasks/schedule | Fri 3/6/20 | Fri 3/6/20 |
| 20 | | 2: Data Gap Evaluation | Mon 2/24/20 | Tue 3/31/20 |
| 21 | | 3: Preparation for Public Meeting | Wed 4/1/20 | Tue 6/30/20 |
| 22 | | 4: Notice for Public Meeting in local newspaper and on BREC CCR website | Wed 7/8/20 | Wed 7/8/20 |
| 23 | | 5: Submit PowerPoint Presentation for client review | Mon 4/13/20 | Mon 4/13/20 |
| 24 | | 6: Client review of PowerPoint Presentation | Mon 4/13/20 | Tue 6/30/20 |
| 25 | | 7: Revise PowerPoint Presentation | Tue 6/30/20 | Thu 7/2/20 |
| 26 | | 8: Public Meeting to present ACM results (40 CFR 257.96(e)) | Thu 7/16/20 | Thu 7/16/20 |
| 27 | | 9: Develop Final Remedy Selection Report (FRSR) | Mon 3/30/20 | Fri 5/15/20 |
| 28 | | 10: Submit FRSR for client review | Fri 5/15/20 | Fri 5/15/20 |
| 29 | | 11: Client review of FRSR | Mon 5/18/20 | Thu 6/11/20 |
| 30 | | 12: Incorporate client comments in FRSR | Fri 6/12/20 | Thu 6/18/20 |
| 31 | | 13: Submit FRSR for KDEP Review | Fri 6/19/20 | Fri 6/19/20 |
| 32 | | 14: KDEP Review of FRSR | Fri 6/19/20 | Fri 8/21/20 |
| 33 | | 15: Address KDEP comments on FRSR | Mon 8/24/20 | Mon 10/5/20 |
| 34 | | 16: Post Final FRSR to CCR Website | Wed 10/7/20 | Wed 10/7/20 |
| 35 | | 17: Groundwater Remedy Implementation (within 90 days of selecting a remedy under 40 CFR 257.97) | Wed 10/21/20 | Tue 1/26/21 |




Project: Green LF_Peri Seep+GW
Date: Wed 10/7/20

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

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# Semi-Annual Remedy Selection Progress Report

Reid/HMP&L Surface Impoundment
Sebree Generating Station
Webster County, Kentucky

Prepared for:

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Sebree Generating Station
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June 2020

## Quality information

| Prepared by | Checked by | Verified by | Approved by |
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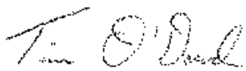
|  |  |  |  |
| Timothy P. O'Dowd, PG | Dennis P. Connair, PG | Joseph B. Suhre | Dennis P. Connair, PG |
| Project Manager | Principal Geologist | Principal Engineer | Principal Geologist |

## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
|---|---|---|---|---|---|
| 1 | June 2020 | | | | |
| | | | | | |
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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 Reid/Henderson Municipal Power & Light (Reid/HMP&L) Surface Impoundment (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 one monitoring well (MW-10) 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 Part 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 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. BREC owns Green and Reid Stations, while the City of Henderson owns HMP&L Station 2. 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 Reid/HMP&L Station Surface Impoundment is illustrated in **Figure 2**. The Surface Impoundment 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 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. Most of the central portion of the south dike was constructed on a subdued ridge.

## 2.2 Groundwater Investigation Summary

Monitoring wells were installed around the perimeter of the Unit in December 2015 prior to the implementation of the CCR Rule. These wells meet the requirements of Title 40 CFR Part 257.90 of the CCR Rule for installation of a groundwater monitoring system. Under these requirements monitoring wells must adequately represent the quality of background groundwater and groundwater representing the downgradient waste boundary. The existing wells are located along the perimeter of the footprint for the Unit. One upgradient monitoring well (MW-7) and three downgradient monitoring wells (MW-8, MW-9, and MW-10) were installed adjacent to the Unit to determine the general direction of groundwater movement and to monitor groundwater impacts. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer.

Nine rounds of Baseline groundwater sampling for Appendix III constituents was conducted between March 2016 and October 2017. Statistical evaluation of Appendix III constituents monitored for Detection monitoring indicated that statistically significant increases (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, 2019, and 2020).

As part of Assessment monitoring, upgradient and downgradient wells for the Unit were sampled for Appendix IV constituents in April, July, and September 2018. GWPS 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 – Reid/HMP&L Surface Impoundment Constituents of Concern**

| Monitoring Well (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** |

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-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 lithium in MW-110 were below the GWPS. The additional characterization data are summarized in **Table 2** below.

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

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

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

Semi-annual Assessment monitoring continued at the Unit in 2019 and 2020 in accordance with 40 CFR Part 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 upland area near the west bank of the Green River. The uppermost edge of the earthen embankment is situated at an elevation of approximately 429 feet above mean sea level (amsl). 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 Unit outflow structure and is routed, under a Kentucky Pollution Discharge and Elimination System 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 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 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. 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 425 ft., amsl at the northeast end (at MW-7), and 388 ft. amsl at the west end of the Unit (at MW-9).

Groundwater elevation data collected in October 2019 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**). Flow direction beneath the Unit is to the southwest towards an unnamed tributary to Groves Creek located west-southwest of the impoundment.

**Table 3. Reid/HMP&L Surface Impoundment – October 2019 Groundwater Elevation Data**

| Monitoring Well | Top of Casing Elevation (ft) [1] | Depth to Groundwater (ft) | Groundwater Elevation (ft, amsl) |
|---|---|---|---|
| MW-7 | 444.43 | 18.59 | 425.84 |
| MW-8 | 394.29 | 5.20 | 389.09 |
| MW-9 | 395.40 | 7.35 | 388.05 |
| MW-10 | 422.27 | 33.28 | 388.99 |

1 Reference elevation of monitoring wells surveyed by Associated Engineers, Inc., Madisonville, Kentucky, January 2015. Survey coordinates were based on the Kentucky State Plane, Kentucky Southern Zone, NAD27 datum.

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 $3 \times 10^{-6}$ to $5 \times 10^{-4}$ 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

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 monitoring well MW-10 southwest of the Unit.

### 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

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. Reid/HMP&L Surface Impoundment - April 2020 Lithium Analytical Results**

| Monitoring Well (Date) | Parameter |
|---|---|
| | Lithium GWPS 0.04 (mg/L) |
| MW-7 | 0.007 |
| MW-8 | 0.03 |
| MW-9 | 0.01 |
| MW-10 | 0.49 |
| MW-110 | 0.02 |

**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 as seepage from beneath the surface impoundment, however there is currently no feasible means of directly tracing that potential under the footprint of the Unit.

### 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

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

## 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 Part 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 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. |

| Potentially Applicable Technology | Status | Description/Overview |
|---|---|---|
| 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 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
- 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 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 ACM performed for the Unit in June 2019 identified a total of five (5) 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 Part 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).

Three (3) potential corrective measures alternatives have been identified by BREC as viable options to address lithium impacts in groundwater at the Unit, including:

- Alternative #2a: CiP, ICs, and Groundwater Monitoring
- Alternative #3: CiP, ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4: CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

Each of the remaining 3 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 planned Reid/HMP&L 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 document the effectiveness of the corrective measures.

Alternative #2a is recommended for further evaluation.

### 3.1.2 Alternative #3 – CiP, ICs, Hydraulic Containment, Ex-Situ Treatment, 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.

Alternative #3 is recommended for further evaluation.

### 3.1.3 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 closure.

Alternative #4 is recommended for further evaluation.

## 3.2 Remedy Evaluation

Currently BREC considers the (3) potential corrective action alternatives as viable options to address groundwater impacts at the Unit, including:

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

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.

## 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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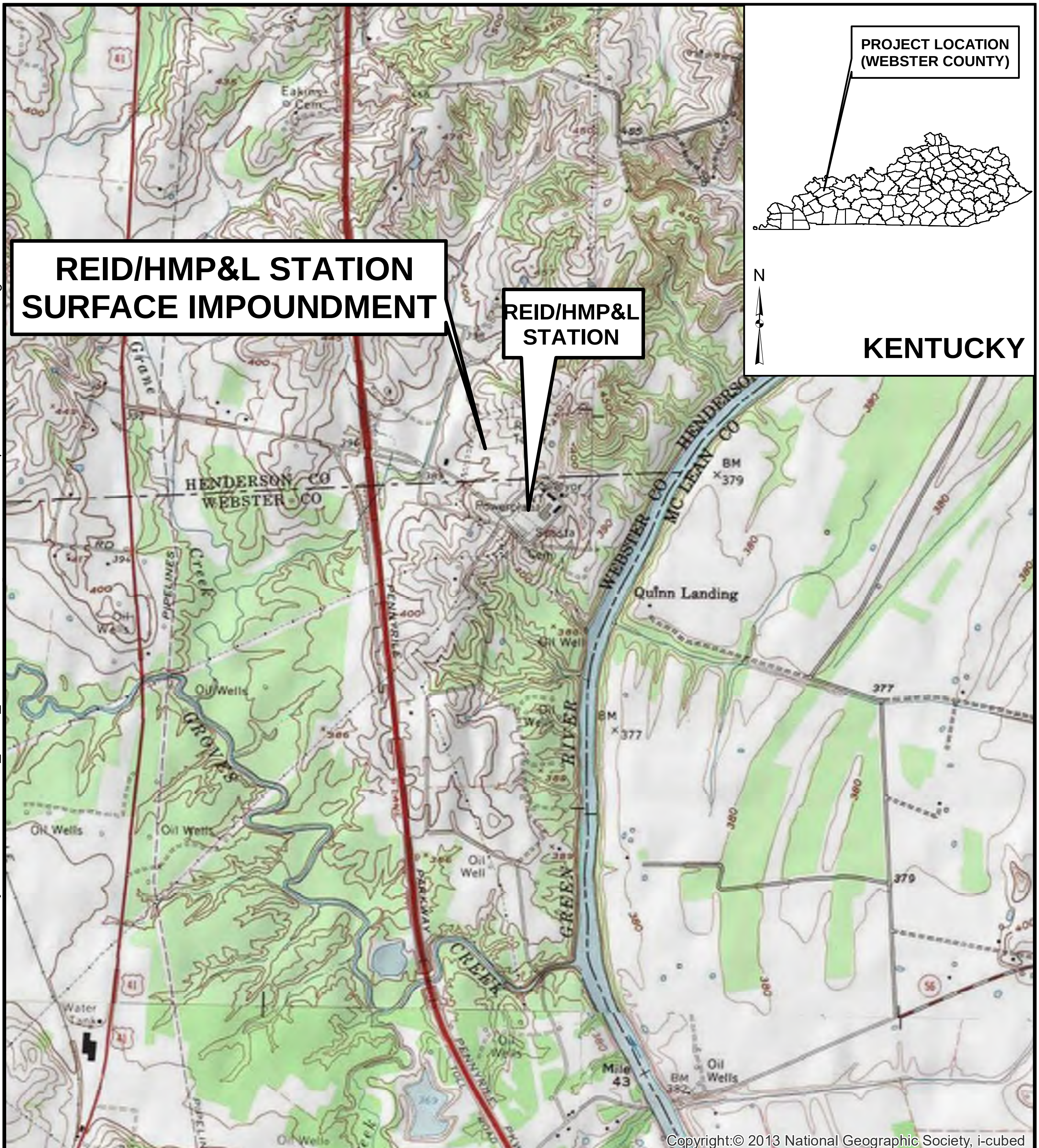


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Big Rivers ELECTRIC CORPORATION

*Reid/HMPL Station*
*Webster County, Kentucky*

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

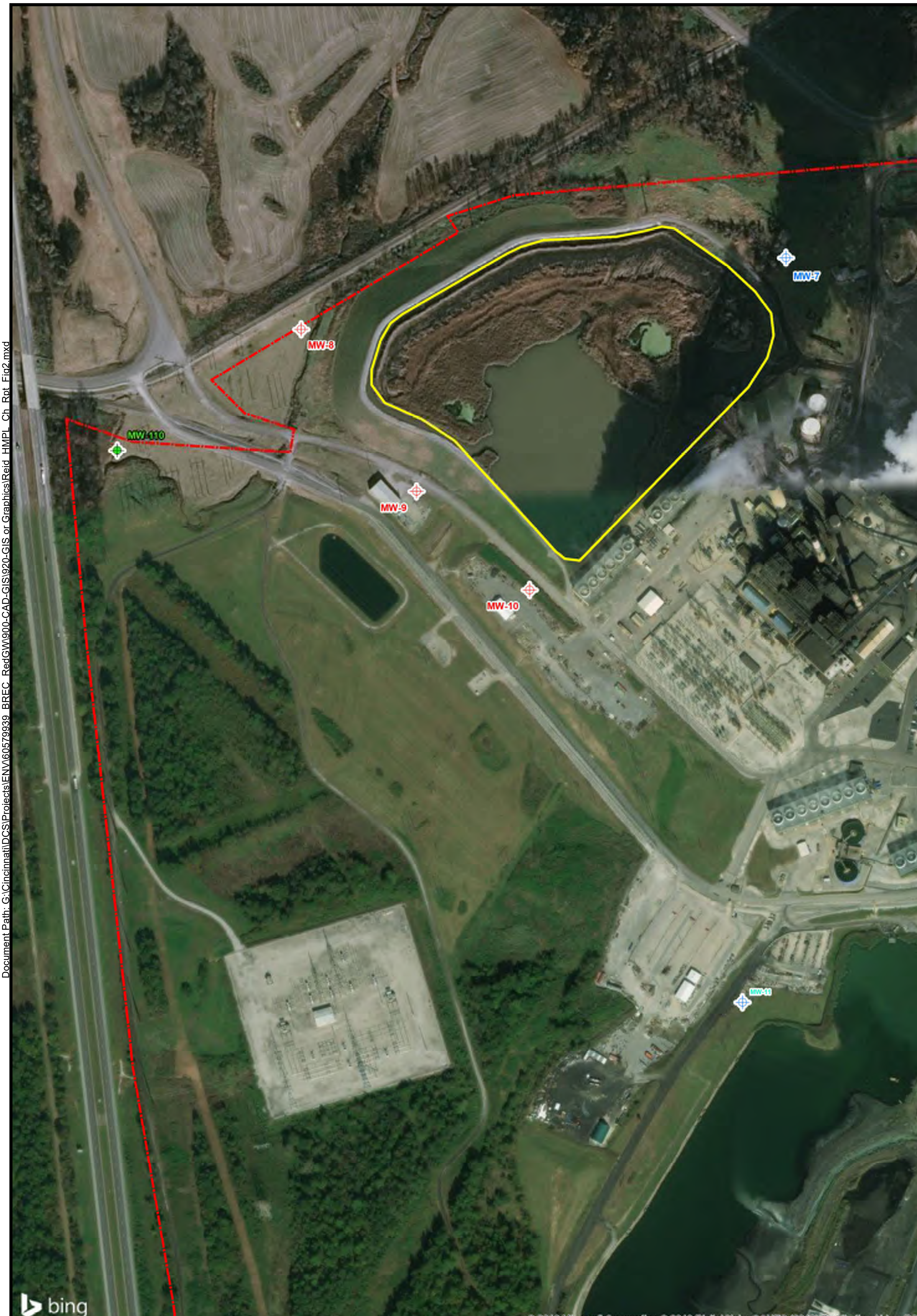
ROBARDS QUADRANGLE
DELAWARE QUADRANGLE
(FROM ARCGIS ONLINE Copyright:© 2011 National Geographic Society, i-cubed)

0 2,000 4,000 Feet

N

FIGURE 1
SITE LOCATION MAP

| | |
|---|---|
| DATE: 4/30/2019 | SCALE: 1IN = 2,000 FEET |
| CREATED BY: ALW | |
| JOB NO. 60602365 | |

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**Legend**

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

0 300 600
Feet

N

Big Rivers ELECTRIC CORPORATION

*Reid/HMPL Station*
*Webster County, Kentucky*

FIGURE 2
WELL LOCATION MAP

| | |
|---|---|
| DATE: 12/9/2019 | SCALE: 1IN = 200 FEET |
| CREATED BY: ALW | |
| JOB NO. 60602365 | |

Document Path: G:\Cincinnati\DCS\GIS\ArcMap_GeoDB_Projects\ENV\60579939_BREC_RedGW\GIS\Fig7_GWS_Map_Reid_Oct2019.mxd


**Legend**

- Proposed Assessment Well
- Downgradient Monitoring Well
- Upgradient Monitoring Well
- Unit Boundary
- Property Line
- Water Table Contour (Inferred from Available Monitoring Data)
- Groundwater Flow Direction
- 389.09 Groundwater Elevation (Feet, MSL) Measured October 16, 2019

0 300 600
Feet

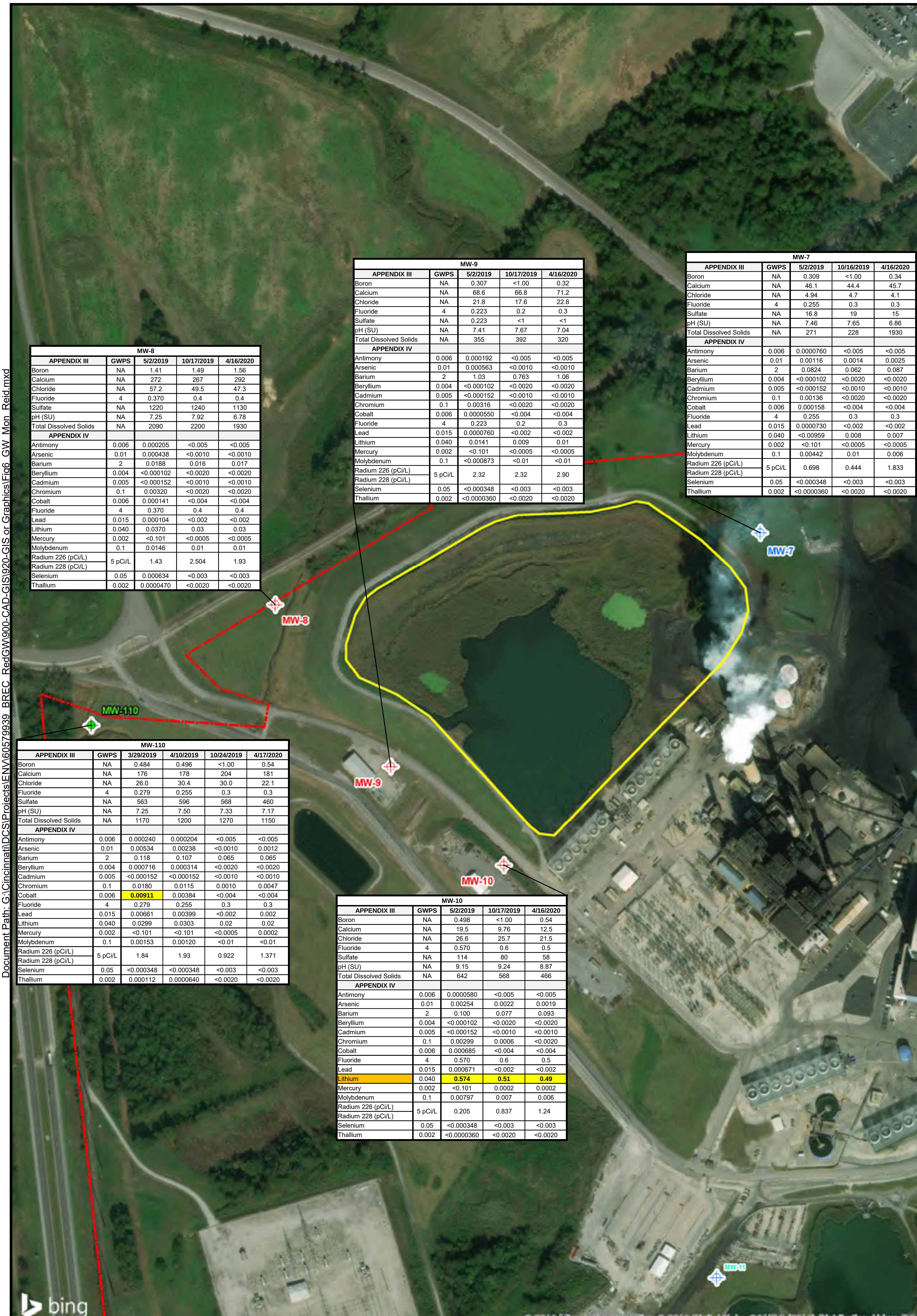
N

Big Rivers

*Reid/HMPL Surface Impoundment*
*Webster County, Kentucky*

FIGURE 3
GROUNDWATER SURFACE MAP
OCTOBER 2019

| | |
|---|---|
| DATE: 12/11/2019 | SCALE: 1IN = 200 FEET |
| CREATED BY: BAW | |
| JOB NO. 60579939 | |




| MW-8 | | | | |
|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **5/2/2019** | **10/17/2019** | **4/16/2020** |
| Boron | NA | 1.41 | 1.49 | 1.56 |
| Calcium | NA | 272 | 267 | 292 |
| Chloride | NA | 57.2 | 49.5 | 47.3 |
| Fluoride | 4 | 0.370 | 0.4 | 0.4 |
| Sulfate | NA | 1220 | 1240 | 1130 |
| pH (SU) | NA | 7.25 | 7.92 | 6.78 |
| Total Dissolved Solids | NA | 2090 | 2200 | 1930 |
| **APPENDIX IV** | | | | |
| Antimony | 0.006 | 0.000205 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.000438 | <0.0010 | <0.0010 |
| Barium | 2 | 0.0188 | 0.016 | 0.017 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00320 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.000141 | <0.004 | <0.004 |
| Fluoride | 4 | 0.370 | 0.4 | 0.4 |
| Lead | 0.015 | 0.000104 | <0.002 | <0.002 |
| Lithium | 0.040 | 0.0370 | 0.03 | 0.03 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | 0.0146 | 0.01 | 0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 1.43 | 2.504 | 1.93 |
| Selenium | 0.05 | 0.000634 | <0.003 | <0.003 |
| Thallium | 0.002 | 0.0000470 | <0.0020 | <0.0020 |

| MW-9 | | | | |
|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **5/2/2019** | **10/17/2019** | **4/16/2020** |
| Boron | NA | 0.307 | <1.00 | 0.32 |
| Calcium | NA | 68.6 | 66.8 | 71.2 |
| Chloride | NA | 21.8 | 17.6 | 22.8 |
| Fluoride | 4 | 0.223 | 0.2 | 0.3 |
| Sulfate | NA | 0.223 | <1 | <1 |
| pH (SU) | NA | 7.41 | 7.67 | 7.04 |
| Total Dissolved Solids | NA | 355 | 392 | 320 |
| **APPENDIX IV** | | | | |
| Antimony | 0.006 | 0.000192 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.000563 | <0.0010 | <0.0010 |
| Barium | 2 | 1.03 | 0.763 | 1.06 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00316 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.0000550 | <0.004 | <0.004 |
| Fluoride | 4 | 0.223 | 0.2 | 0.3 |
| Lead | 0.015 | 0.0000760 | <0.002 | <0.002 |
| Lithium | 0.040 | 0.0141 | 0.009 | 0.01 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | <0.000873 | <0.01 | <0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 2.32 | 2.32 | 2.90 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

| MW-7 | | | | |
|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **5/2/2019** | **10/16/2019** | **4/16/2020** |
| Boron | NA | 0.309 | <1.00 | 0.34 |
| Calcium | NA | 46.1 | 44.4 | 45.7 |
| Chloride | NA | 4.94 | 4.7 | 4.1 |
| Fluoride | 4 | 0.255 | 0.3 | 0.3 |
| Sulfate | NA | 16.8 | 19 | 15 |
| pH (SU) | NA | 7.46 | 7.65 | 6.86 |
| Total Dissolved Solids | NA | 271 | 228 | 1930 |
| **APPENDIX IV** | | | | |
| Antimony | 0.006 | 0.0000760 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00116 | 0.0014 | 0.0025 |
| Barium | 2 | 0.0824 | 0.062 | 0.087 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00136 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.000158 | <0.004 | <0.004 |
| Fluoride | 4 | 0.255 | 0.3 | 0.3 |
| Lead | 0.015 | 0.0000730 | <0.002 | <0.002 |
| Lithium | 0.040 | <0.00959 | 0.008 | 0.007 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | 0.00442 | 0.01 | 0.006 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 0.698 | 0.444 | 1.833 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

| MW-110 | | | | | |
|---|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **3/29/2019** | **4/10/2019** | **10/24/2019** | **4/17/2020** |
| Boron | NA | 0.484 | 0.496 | <1.00 | 0.54 |
| Calcium | NA | 176 | 178 | 204 | 181 |
| Chloride | NA | 26.0 | 30.4 | 30.0 | 22.1 |
| Fluoride | 4 | 0.279 | 0.255 | 0.3 | 0.3 |
| Sulfate | NA | 563 | 596 | 568 | 460 |
| pH (SU) | NA | 7.25 | 7.50 | 7.33 | 7.17 |
| Total Dissolved Solids | NA | 1170 | 1200 | 1270 | 1150 |
| **APPENDIX IV** | | | | | |
| Antimony | 0.006 | 0.000240 | 0.000204 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00534 | 0.00238 | <0.0010 | 0.0012 |
| Barium | 2 | 0.118 | 0.107 | 0.065 | 0.065 |
| Beryllium | 0.004 | 0.000716 | 0.000314 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.0180 | 0.0115 | 0.0010 | 0.0047 |
| Cobalt | 0.006 | **0.00911** | 0.00384 | <0.004 | <0.004 |
| Fluoride | 4 | 0.279 | 0.255 | 0.3 | 0.3 |
| Lead | 0.015 | 0.00661 | 0.00399 | <0.002 | 0.002 |
| Lithium | 0.040 | 0.0299 | 0.0303 | 0.02 | 0.02 |
| Mercury | 0.002 | <0.101 | <0.101 | <0.0005 | 0.0002 |
| Molybdenum | 0.1 | 0.00153 | 0.00120 | <0.01 | <0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 1.84 | 1.93 | 0.922 | 1.371 |
| Selenium | 0.05 | <0.000348 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | 0.000112 | 0.0000640 | <0.0020 | <0.0020 |

| MW-10 | | | | |
|---|---|---|---|---|
| **APPENDIX III** | **GWPS** | **5/2/2019** | **10/17/2019** | **4/16/2020** |
| Boron | NA | 0.498 | <1.00 | 0.54 |
| Calcium | NA | 19.5 | 9.76 | 12.5 |
| Chloride | NA | 26.6 | 25.7 | 21.5 |
| Fluoride | 4 | 0.570 | 0.6 | 0.5 |
| Sulfate | NA | 114 | 80 | 58 |
| pH (SU) | NA | 9.15 | 9.24 | 8.87 |
| Total Dissolved Solids | NA | 642 | 568 | 466 |
| **APPENDIX IV** | | | | |
| Antimony | 0.006 | 0.0000580 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00254 | 0.0022 | 0.0019 |
| Barium | 2 | 0.100 | 0.077 | 0.093 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00299 | 0.0006 | <0.0020 |
| Cobalt | 0.006 | 0.000685 | <0.004 | <0.004 |
| Fluoride | 4 | 0.570 | 0.6 | 0.5 |
| Lead | 0.015 | 0.000671 | <0.002 | <0.002 |
| Lithium | 0.040 | **0.574** | **0.51** | **0.49** |
| Mercury | 0.002 | <0.101 | 0.0002 | 0.0002 |
| Molybdenum | 0.1 | 0.00797 | 0.007 | 0.006 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 0.205 | 0.837 | 1.24 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

**Legend**

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

0 300 600
Feet

N

Big Rivers

*Reid/HMPL Surface Impoundment*
*Webster County, Kentucky*

FIGURE 4
GROUNDWATER CONDITIONS MAP
2019-2020 ANALYTICAL RESULTS

| | |
|---|---|
| DATE: 6/10/2020 | SCALE: 1IN = 200 FEET |
| CREATED BY: SEL | |
| JOB NO. 60619822 | |

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# Semi-Annual Remedy Selection Progress 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:

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June 8, 2020

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## Revision History

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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 $2 \times 10^{-5}$ to $3 \times 10^{-3}$ 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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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.

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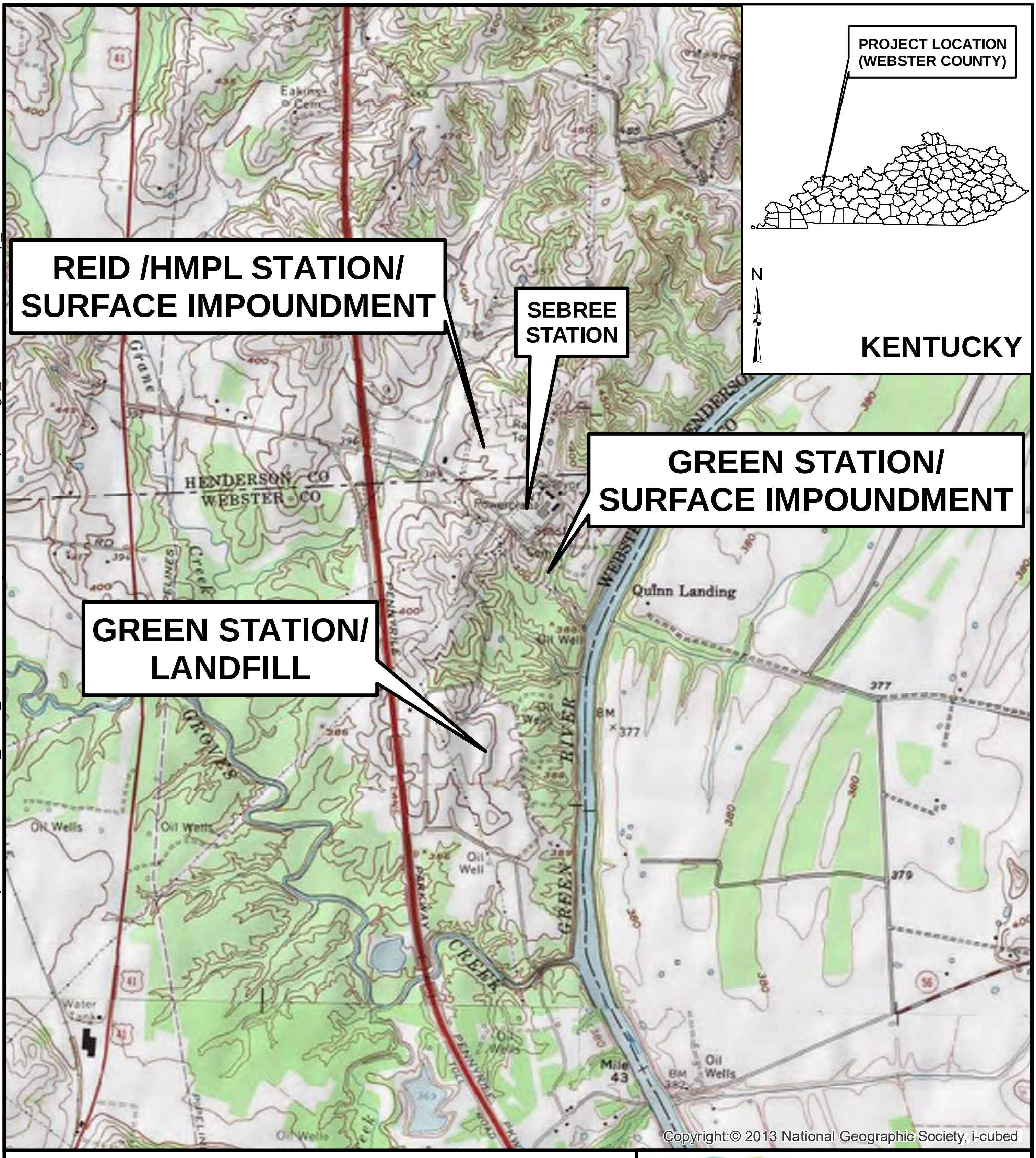
# Figures




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

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 | |

Document Path: G:\Cincinnati\DCS\GIS\ArcMap_GeoDB_Projects\ENV\60579938_BREC_GrnGW\920-GIS or Graphics\Fig2_REC_Green.mxd


**Legend**

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

0 400 800
Feet

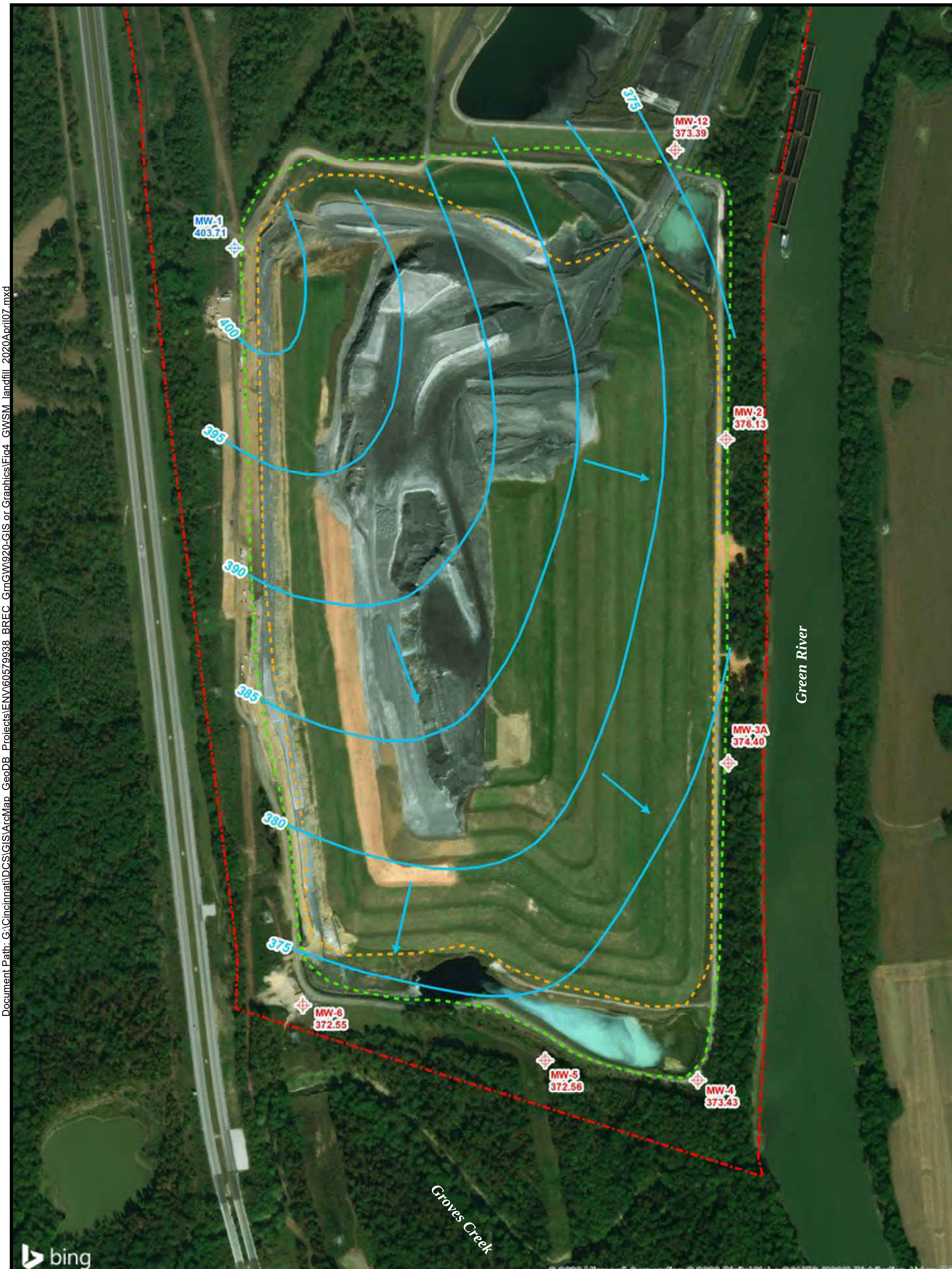
N

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 | |




**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

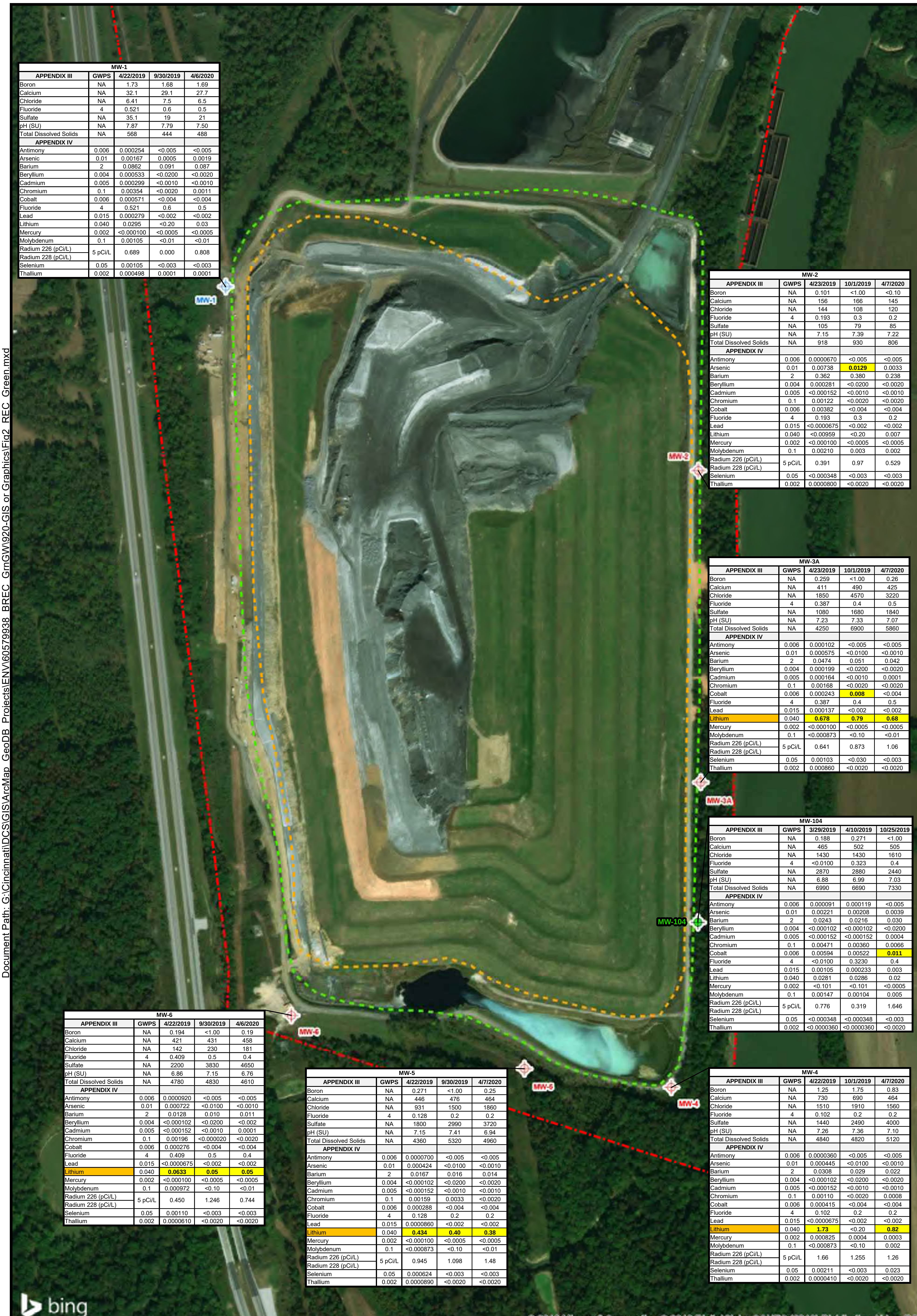
N

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 | |




| 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

*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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# REMEDY SELECTION PROGRESS REPORT

## GREEN LANDFILL
## SEBREE STATION
## WEBSTER COUNTY, KENTUCKY

**December 9, 2019**

*Prepared For:*

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

*Prepared by:*


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# 1.0 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) Section 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 Section 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 Section 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 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 following sections 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).

# 2.0 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 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 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 requirements are that wells must 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 (**Figure 2**). 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. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer.

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 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 and 2019).

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

**Table 1 Green Station CCR 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 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 Station CCR Landfill Characterization Sample Results**

| Monitoring Well (Date) | Parameter |
|---|---|
| | **Lithium UPL 0.008 GWPS 0.04 (mg/L)** |
| MW-104 (March 2019) | 0.0281 |
| MW-104 (April 2019) | 0.0288 |

The results from both characterization sampling events helped to confirm the downgradient (southwestern) extent of COC impacts above GWPS at the Green Landfill. However, downgradient characterization is limited due to the presence of the Green River immediately adjacent to the Unit.

## 2.3 Conceptual Site Model

A Conceptual Site Model (CSM) has been developed to support the remedy selection process for groundwater corrective action at the Unit.

### 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, the Ohio, the Kentucky, the 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 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 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 permit. 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 Unit does not have a leachate collection and management system, although systems are being constructed as part of Interim Corrective Measures for non-groundwater impacts.

### 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.

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 over 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 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). Flow direction beneath the Unit is typically southeast towards the Green River.

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 $2x10^{-5}$ to $3x10^{-3}$ 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 (COC)

As discussed above, a single Appendix IV COC (lithium) was detected at concentrations exceeding GWPS in multiple monitoring well locations. As a result, the corrective measure evaluation is confined to the area between and adjacent to the wells in which the exceedances were identified (MW-3A, MW-4, MW-5, and MW-6).

### 2.3.5 Potential Receptors/Exposure 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 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 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).

## 2.4 Interim Corrective Measures

No formal interim corrective measures have been performed at the Green Landfill for groundwater, but corrective measures for known non-groundwater releases are underway. The compatibility of those corrective measures with potential groundwater remedies is being evaluated as part of the remedy selection process.

## 2.5 Assessment of Corrective Measures Summary

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).

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 in **Table 3** 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 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. |

| 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 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 Unit, six 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
- 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 is considered 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.

# 3.0 REMEDY SELECTION PROGRESS

Six corrective measure alternatives were identified during the ACM process for potential implementation at the Unit to address groundwater impacts. Each corrective measure alternative consists of one or more corrective measures technologies assembled into a strategy for the groundwater remedy. Each alternative is discussed in more detail below.

## 3.1 Potential Corrective Action Alternatives

### 3.1.1 Alternative #1 – No Action and Groundwater Monitoring

Alternative #1 consists of taking no action to address groundwater impacts at the Unit. Under the No Action alternative, no corrective action would be implemented to remove, control, mitigate, or minimize exposure to impacted groundwater. The No Action alternative establishes a baseline or reference point against which each of the corrective measure alternatives is compared.

Since Alternative #1 would not attain the CAOs for the Unit, this alternative would not likely be acceptable to stakeholders. Therefore, Alternative #1 is not recommended for further consideration.

### 3.1.2 Alternative #2a – Closure in Place (CiP), Institutional Controls (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.

### 3.1.3 Alternative #2b – Closure by Removal (CbR), ICs, and Groundwater Monitoring

Alternative #2b as currently envisioned would be similar to Alternative #2a except that CiP is replaced by CbR, which consists of excavation and removal of the Unit. Given that Alternative #2b is likely cost prohibitive, this alternative is not recommended for further consideration.

### 3.1.4 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., draining and lining 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.

### 3.1.5 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.

### 3.1.6 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.

# 4.0 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 June 2020.

## 5.0 REFERENCES

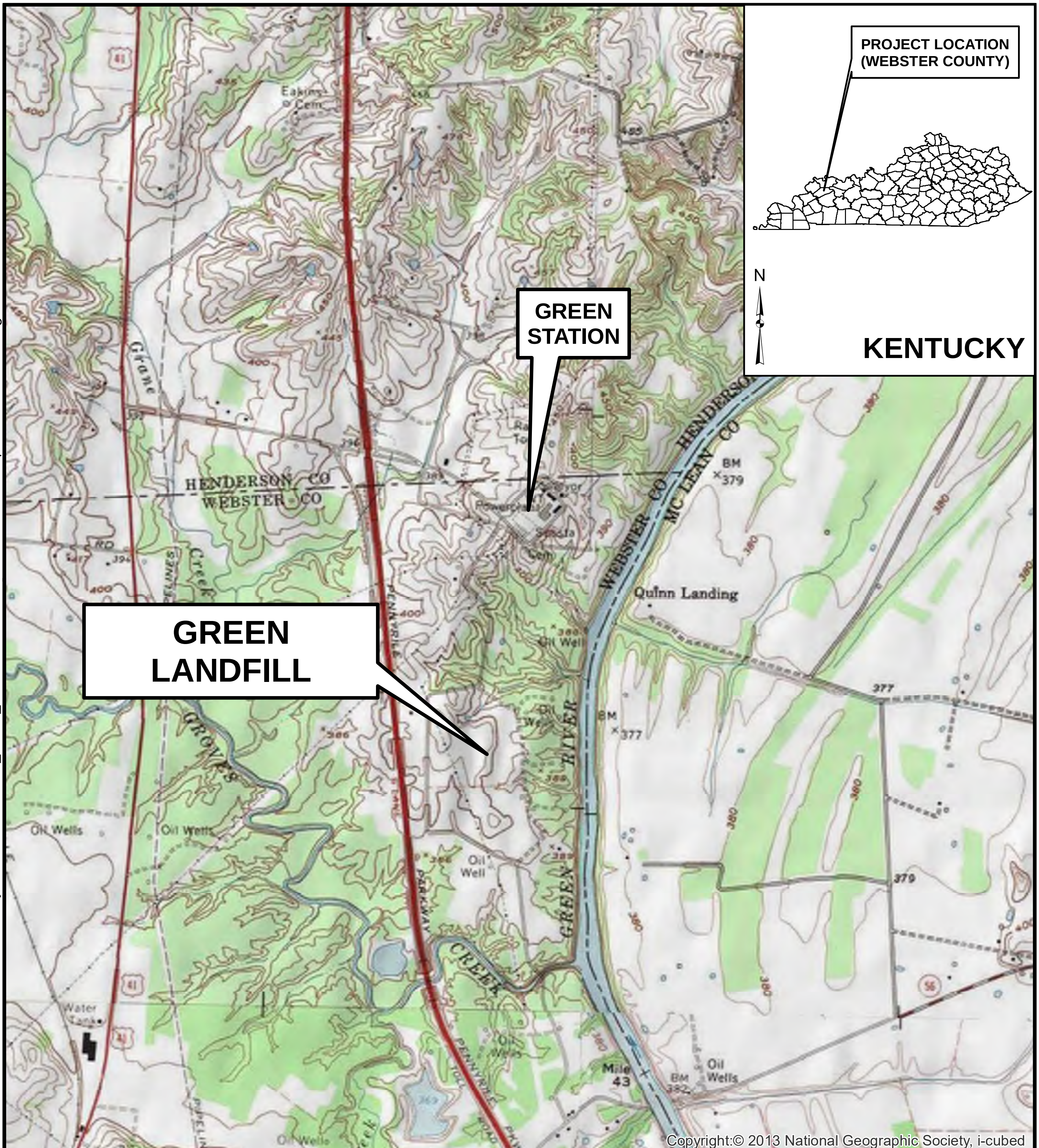
AECOM, 2018. Annual Groundwater Monitoring and Corrective Action Report, 2016-2017; Green Station CCR Landfill, Webster County, Kentucky.

AECOM, 2019. Annual Groundwater Monitoring and Corrective Action Report, 2018; Green Station CCR Landfill, Webster County, Kentucky.

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

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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

*Green Station*
*Webster County, Kentucky*

FIGURE 1
SITE LOCATION MAP

| | |
|---|---|
| DATE: 4/30/2019 | SCALE: 1IN = 2,000 FEET |
| CREATED BY: ALW | |
| JOB NO. 60602364 | |

Document Path: G:\Cincinnati\DCS\GIS\ArcMap GeoDB Projects\ENV\60579938 BREC GrnGW\920-GIS or Graphics\Fig2 REC Green.mxd


**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

*Green Station*
*Webster County, Kentucky*

FIGURE 2
WELL LOCATION MAP

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

# ATTACHMENT 9 – AGREED ORDER

COMMONWEALTH OF KENTUCKY
ENERGY AND ENVIRONMENT CABINET
DIVISION OF WASTE MANAGEMENT
Permit No. SW11700007
AI No. 4196
FILE NO. 18-3-0138



IN RE: R.D. GREEN LANDFILL

BIG RIVERS ELECTRIC CORPORATION
201 3rd Street
P.O. Box 24
Henderson, KY 42420

Facility/Violation Location:
Big Rivers Electric Corp. – Sebree Station
9000 Highway 2096
Robards, KY 42452

**AGREED ORDER**

* * * * * * * * * * * *

**WHEREAS**, the parties to this Agreed Order, the Energy and Environment Cabinet (hereinafter "Cabinet") and Big Rivers Electric Corporation (hereinafter "BREC"), state:

**STATEMENTS OF FACT**

1. The Cabinet is charged with the statutory duty of enforcing KRS Chapter 224, and the regulations promulgated pursuant thereto.

2. KRS 224.50-760 governs the disposal of special waste, including utility wastes. The Cabinet promulgated regulations at 401 KAR Chapters 45 and 46 to implement its duty to regulate the disposal of special wastes.

3. In 2015, the United States Environmental Protection Agency ("EPA") promulgated 40 CFR 257.50 – 257.107 establishing national standards to govern the location, design,

construction and operation of landfills and surface impoundments for the disposal of utility wastes known as coal combustion residuals ("CCR") (hereinafter "Federal CCR Rule"). As promulgated, the Federal CCR Rule is self-implementing. In 2017, the Cabinet promulgated 401 KAR 46:110 to incorporate the federal standards into Kentucky regulations. 401 KAR 46:110 Sections 5 and 8 incorporate inspection, control, assessment, and corrective action requirements set forth in 40 CFR 257.81, 257.84, and 257.90 that apply to surface run-off and unauthorized surface releases from existing CCR landfills. Under the Federal CCR Rule, existing CCR landfills, as defined at 40 CFR 257.53, were authorized to continue operation without installing leachate collection systems. 80 Fed. Reg. 21302, 21370 (April 17, 2015).

4. BREC owns and operates Sebree Station, an electric power generating station located in Henderson and Webster Counties, Kentucky (the "Facility"). BREC owns and operates a special waste landfill at the Facility for the disposal of utility wastes including CCR (hereinafter the "Green Landfill") generated at Sebree Station. The site has been assigned AI ID No. 4196. To operate the Green Landfill the Cabinet's Division of Waste Management, Solid Waste Branch (DWM), issued BREC Special Waste Permit No. SW11700007 pursuant to 401 KAR Chapter 45. Operating authorization was received on September 13, 1987.

5. Green Landfill is an existing CCR landfill under the Federal CCR Rule and is therefore subject to the operating criteria and corrective action standards of 401 KAR 46:110, that incorporate the 40 CFR Part 257 standards. Those standards apply independent of the terms of the 401 KAR Chapter 45 permit.

6. BREC holds Kentucky Pollution Discharge Elimination System ("KPDES") Permit No. KY0001929 issued by the Cabinet's Division of Water ("DOW") on June 15, 2018

(hereinafter "KPDES Permit") regulating discharges from point sources at the Facility into Waters of the Commonwealth pursuant to 401 KAR 5:055. Outfalls 001, 009, 012 and 014 are controlled by sedimentation basins and are authorized to discharge CCR landfill runoff and leachate from the Green Landfill.

7. In June 2017, authorized representatives of DWM conducted an inspection of the Green Landfill and observed leachate outbreaks and leachate flowing in unlined ditches from the landfill toward the sedimentation basins at Outfalls 012 and 014. Additionally, surface seeps were identified by DWM along the eastern side of the Green Landfill on the natural ground slope between the haul road and the Green River that, if not controlled, have the potential to flow to the Green River.

8. On or about July 12 and 13, 2018, BREC conducted water sampling along the Green River to determine whether any seeps or other impacts to the surface water could be attributed to leachate outbreaks from the Green Landfill. Results from in-river samples and a majority of seep samples generally fell within regulatory limits.

9. On or about December 10, 2018, DWM and BREC conducted a joint leachate and sampling event of four (4) locations adjacent to the Green Landfill. Sampling results produced by both DWM and BREC indicated chlorides were present in elevated levels at all four sampling locations. An inspection report detailing the sampling event was issued on May 20, 2019.

10. On April 2, 2019, DWM and DOW conducted a joint inspection of the Green Landfill and observed seepage and stormwater from below the northwestern side of the landfill flowing in an unlined ditch toward the Green River. Analysis of the seepage and stormwater indicates it contains CCR-related constituents but the concentrations did not exceed Kentucky's water quality standards.

11. On May 2, 2019, DOW issued a Notice of Violation ("NOV") to BREC for an unpermitted discharge based upon the April 2, 2019 inspection. The remedial measures required that the discharge be added to the KPDES permit for the facility and addressed through the best management practices required under the permit. BREC responded to the NOV in July 2019 and submitted a KPDES permit modification application for the stormwater runoff in the culvert identified during the April 2, 2019 inspection.

12. On May 20, 2019, DWM issued an NOV to BREC for the seep identified during the April 2, 2019 inspection. The remedial measures required that BREC address the seep pursuant to 401 KAR 46:110. BREC responded to the NOV on July 30, 2019 and identified its remedial measures.

13. BREC and DWM met on several occasions in 2017, 2018, and 2019 to discuss BREC's leachate management activities and remedial plans at the Facility. BREC noted that it had implemented procedures for control of leachate outbreaks and had authorized a consulting firm to evaluate and design remedies for the seeps on the northwestern side of the Green Landfill and those located below the eastern side of the landfill along the bank of the Green River. BREC revised its run-off plan for leachate that is required by 40 CFR 257.81 and has developed standard operating procedures ("SOPs") for leachate outbreaks that are intended to ensure compliance with 40 CFR 257.81, 257.84(b)(5), and 257.90(d), as incorporated in 401 KAR 46:110, and KPDES permit requirements for leachate management.

14. The Cabinet and BREC acknowledge that EPA is in the process of reconsidering the scope and applicability of response requirements for non-groundwater releases from CCR landfills. Any final amendments to those standards will automatically become effective under 401 KAR 46:110 due to the federal standards being incorporated by reference, and in such an event

the SOPs set forth in this Agreed Order would be subject to change or amendment. The Cabinet is also in the process of developing amended regulations at 401 KAR Chapter 46 to address procedures for permitting for groundwater and non-groundwater release corrective action at CCR units, which, when effective, will apply to the Green Landfill and may, as appropriate, result in BREC's reconsideration of the remedies implemented under this Agreed Order.

15. The Cabinet asserts that improved leachate and seep management is necessary to ensure compliance with surface water standards, as reflected in the Facility's KPDES permit, to prevent degradation of the waters of the Commonwealth from uncontrolled surface seeps, and to reduce the risk of impacts to groundwater. As set forth herein, the parties have agreed upon remedial measures intended to ensure leachate and seeps are managed at the Green Landfill in a manner to comply with the facility's KPDES permit, the special waste landfill permit, and applicable CCR landfill regulations as incorporated at 401 KAR 46:110 Section 8 for non-groundwater releases.

16. To arrive at the terms of this Agreed Order, BREC provided DWM with its leachate SOPs, and the remedial assessment design plans and schedules for the surface seeps along the slopes below the Green Landfill. The Cabinet reviewed the plans and determined the proposed SOPs and BREC's remedial assessment plans and milestones for completing remedial measures for the seeps to be acceptable response actions to address concerns for potential operational deficiencies and releases associated with the leachate outbreaks and seeps. While negotiating this Agreed Order, BREC initiated contracting of the engineered containment controls developed as remedies under 40 CFR 257.90(d) and 257.84(b)(5) that are intended to reduce and prevent impacts from the Green Landfill surface seeps to the Green River based upon the design plans that were submitted to the Cabinet for review and comment. BREC is now proceeding with

construction of those remedial projects. The construction schedule and post construction performance monitoring for those projects are set forth in Exhibits 2 and 3.

17. In January 2019, BREC posted a notice on its CCR Rule compliance website that it had commenced an assessment of corrective measures (ACM) for lithium, a CCR constituent, detected in groundwater beneath the Green Landfill. That notice also stated that BREC had initiated an ACM for the non-groundwater release surface seeps. Both ACMs have been completed and were posted to BREC's CCR Rule compliance website in July 2019.

18. Based upon the leachate and seep management plan commitments and projects, this Agreed Order resolves the DWM and DOW NOVs and concerns of potential deficiencies related to seep and leachate outbreak non-groundwater release response protocols and remedial measures. This Agreed Order also provides the process, as set out in Exhibit 4, for BREC to complete the evaluation of groundwater corrective action remedies at the Green Landfill pursuant to 401 KAR 46:110 and to obtain Cabinet review and comment of the corrective action remedy design, schedule for implementation, and post-construction performance monitoring.

19. Big Rivers neither admits nor denies the assertions of the Cabinet set forth above, but agrees to resolve the DWM and DOW claims regarding non-groundwater leachate releases and seeps at Green Landfill through the development and implementation of remedial measures set forth herein to address any threat or potential threat to human health and the environment associated with management of CCR and leachate at its Facility, to ensure compliance with 401 KAR 46:110 and the Federal CCR Rule as incorporated thereby for non-groundwater and groundwater releases.

**NOW THEREFORE,** in the interest of settling all civil claims and controversies involving the alleged deficiencies described above, the parties hereby consent to the entry of this Agreed Order and agree as follows:

**REMEDIAL MEASURES**

20. BREC shall implement the SOPs set forth in Exhibit 1 to address leachate and seep releases to the surface at the Green Landfill. The SOPs, which have been incorporated into BREC's run on and run off control plans on its CCR Rule compliance website, may be amended as circumstances warrant with written notice provided thirty days (30) in advance to Director of DWM, 300 Sower Blvd., 2nd Floor, Frankfort, KY 40601.

21. BREC shall construct and operate the remedial measures set forth in Exhibits 2 and 3 for the surface seeps along and below the northwestern and eastern sides of Green Landfill to prevent uncontrolled migration of the surface seeps to the Green River. On or about August 23 and September 19, 2019, BREC provided notice to DWM that it was commencing construction of the projects as specified in Exhibits 2 and 3. BREC shall provide written notice to the Solid Waste Branch Manager five (5) business days prior to commencing additional construction projects and within five (5) business days of completing construction of the projects as set forth in Exhibits 2 and 3. For purposes of this section, written notice may be sent to the Solid Waste Branch Manager, 300 Sower Blvd., 1st Floor, Frankfort, KY 40601, and/or electronic mail directed to Danny Anderson, PE, at Danny.Anderson@ky.gov or his successor or designee.

22. BREC may request an amendment of the accepted seep remedial action plans and schedules set forth in Exhibits 2 and 3 in writing sent to the Directors of DWM and the Division of Enforcement at 300 Sower Blvd., 3rd Floor, Frankfort, KY 40601. The request shall state the reasons therefore and include any proposed changes to plans and specifications. The Cabinet shall

review proposed amendments and may, in whole or part, 1) approve or 2) disapprove and provide comments identifying deficiencies. If granted, the Amended Exhibit(s) shall not affect any provision of this Agreed Order unless expressly provided for in the amendment. Amendment under this section does not require an amendment request pursuant to paragraph 32 below.

23. BREC shall follow the process and schedule set out in Exhibit 4 in selecting and implementing a corrective action remedy for the statistically significant increase in lithium in groundwater referenced in its CCR Rule compliance website notification.

**PENALTIES**

24. BREC shall pay the Cabinet a civil penalty in the amount of twenty thousand dollars ($20,000) for the violations alleged above. The amount of the civil penalty shall be due no later than thirty (30) days after this Agreed Order is entered by the Secretary or his designee.

**STIPULATED PENALTIES**

25. BREC shall pay the Cabinet a stipulated penalty in the amount of five hundred ($500) per day, within fifteen (15) days of mailing of written notice from the Cabinet for failure to timely meet any remedial milestones required by Exhibits 2 and 3 to this Agreed Order. This penalty is in addition to, and not in lieu of, any other penalty the Cabinet could assess. The Cabinet may, in its discretion, waive stipulated penalties that would otherwise be due.

26. Within fifteen (15) days of receipt of written demand for payment of a stipulated penalty, BREC shall submit payment of the stipulated penalty. The stipulated penalties are in addition to and not in lieu of, any other penalty that could be assessed. The payment of stipulated penalties shall not alter in any way BREC's obligation to complete the performance of the actions described in this Agreed Order.

27. If BREC believes the request for payment of a stipulated penalty is erroneous or contrary to law, BREC may request a hearing in accordance with KRS 224.10-420(2). The request for hearing does not excuse timely payment of the penalty. If an order is entered pursuant to KRS 224.10-440 that excuses payment, the Cabinet will refund the payment. Failure to make timely payment shall constitute an additional violation.

28. Payment of civil and any stipulated penalties shall be by cashier's check, certified check, or money order, made payable to "Kentucky State Treasurer" and sent to the attention of Director, Division of Enforcement, Department for Environmental Protection, 300 Sower Blvd., Frankfort, Kentucky 40601.

## MISCELLANEOUS PROVISIONS

29. This Agreed Order only resolves those claims, NOVs, and alleged deficiencies specifically described above. Other than those matters resolved by entry of this Agreed Order nothing contained herein shall be construed to waive or to limit any remedy or cause of action by the Cabinet based on statutes or regulations under its jurisdiction and BREC reserves its defenses thereto. The Cabinet expressly reserves its right at any time to issue administrative orders and to take any other action it deems necessary that is not inconsistent with this Agreed Order, including the right to order all necessary remedial measures, assess penalties for violations, or recover all response costs incurred, and BREC reserves its defenses thereto.

30. This Agreed Order shall not prevent the Cabinet from issuing, reissuing, renewing, modifying, revoking, suspending, denying, terminating, or reopening any permit to BREC. BREC reserves its defenses thereto, except that BREC shall not use this Agreed Order as a defense to those permitting actions.

31. BREC waives its right to any hearing on the matters resolved herein. However,

failure by BREC to comply strictly with any or all of the terms of this Agreed Order shall be grounds for the Cabinet to seek enforcement of this Agreed Order in Franklin Circuit Court and to pursue any other appropriate administrative or judicial action under KRS Chapter 224 and the regulations promulgated pursuant thereto.

32. The Agreed Order may not be amended except by a written order of the Cabinet's Secretary or his designee. BREC may request an amendment by writing the Director of Division of Enforcement at 300 Sower Blvd., Frankfort, Kentucky 40601 and stating the reasons for the request. If granted, the amended Agreed Order shall not affect any provision of this Agreed Order unless expressly provided in the amended Agreed Order. The Cabinet and BREC agree that the obligations of this Agreed Order may be modified by final promulgation of EPA's Federal CCR Rule reconsideration rule setting requirements for addressing surface releases, including leachate management at existing CCR landfills, and agree obligations of this Agreed Order shall be superseded and amended by any such final rule, or the Cabinet's amendment of its regulations at 401 KAR Chapter 46, to the extent such rules are inconsistent with this Agreed Order.

33. Unless otherwise stated in this Agreed Order, all submittals required of BREC by this Agreed Order shall be sent to: Director, Division of Enforcement, 300 Sower Blvd., Frankfort, Kentucky 40601.

34. The Cabinet does not, by its consent to the entry of this Agreed Order, warrant or aver in any manner that BREC's complete compliance with this Agreed Order will result in compliance with the provisions of KRS Chapter 224; 401 KAR Chapters 30, 45, and 46; or the Federal CCR Rule. Notwithstanding the Cabinet's review and approval of any plans formulated pursuant to this Agreed Order, BREC shall remain solely responsible for compliance with the

terms of KRS Chapter 224; 401 KAR Chapters 30, 45, and 46; or the Federal CCR Rule, this Agreed Order and any permit and compliance schedule requirements.

35. BREC shall give notice of this Agreed Order to any purchaser, lessee or successor in interest prior to the transfer of ownership and/or operation of any part of its now-existing facility occurring prior to termination of this Agreed Order, shall notify the Cabinet that such notice has been given, and shall follow all statutory and regulatory requirements for a transfer. Whether or not a transfer takes place, BREC shall remain fully responsible for payment of all stipulated penalties and response costs and for performance of all remedial measures identified in this Agreed Order.

36. The Cabinet agrees to allow the performance of the above-listed remedial measures by BREC to satisfy its obligations to the Cabinet generated by the alleged deficiencies described above.

37. The Cabinet and BREC agree that the remedial measures agreed to herein are facility-specific and designed to comply with the statutes and regulations cited herein. This Agreed Order applies specifically and exclusively to the unique facility referenced herein and is inapplicable to any other site or facility.

38. This Agreed Order shall be of no force and effect unless and until it is entered by the Secretary or his designee as evidenced by his signature thereon.

**TERMINATION**

39. This Agreed Order shall terminate upon BREC's completion of all requirements described in this Agreed Order. BREC may submit written notice to the Cabinet when it believes all requirements have been performed. The Cabinet will notify BREC in writing of whether it intends to agree with or object to termination. The Cabinet reserves its right to enforce this Agreed

Order, and BREC reserves its right to file a petition for hearing pursuant to KRS 224.10-420(2) contesting the Cabinet's determination.

**AGREED TO BY:**

Mike W. Chambliss, Vice President System Operations
Big Rivers Electric Corporation

12-6-2019
Date

**HAVE SEEN:**

Jack Bender, Attorney for Big Rivers Electric Corporation
Dinsmore & Shohl LLP

12/6/2019
Date

FILE NO. 18-3-0138

**APPROVAL RECOMMENDED BY:**

Michael Kroeger, Director
Division of Enforcement

12/6/19
Date

Jon Maybriar, Director
Division of Waste Management

12-6-19
Date

John G. Horne, II, Executive Director
Office of Legal Services

12/6/19
Date

**ORDER**

Wherefore, the foregoing Agreed Order is entered as the final Order of the Energy and Environment Cabinet this 6th day of December, 2019.

ENERGY AND ENVIRONMENT CABINET

R. BRUCE SCOTT, DEPUTY SECRETARY
ENERGY AND ENVIRONMENT CABINET

FILE NO. 18-3-0138

## CERTIFICATE OF SERVICE

I hereby certify that a true and accurate copy of the foregoing **AGREED ORDER** was mailed, postage prepaid, to the following this 11th day of December, 2019.

Hon. Jack Bender
Dinsmore & Shohl LLP
Lexington Financial Center
250 West Main Street
Suite 1400
Lexington, KY 40507

and mailed, messenger to:

Daniel Cleveland
Office of Legal Services
300 Sower BLVD, 3rd Floor

Michael Kroeger, Director
Division of Enforcement
300 Sower BLVD, 3rd Floor

Paige Tate
DOCKET COORDINATOR

DWM
BGO
SH

**Exhibit 1**

**Leachate Management Standard Operating Procedures**

**Green Landfill and Green Surface Impoundment**

**Subject: Surface Seep and Leachate Outbreaks Repair**

To ensure compliance with 40 CFR 257 Subpart D and 401 KAR Chapters 45 and 46, the following procedure will be utilized for identification and repair of seeps and leachate outbreaks at CCR landfills and surface impoundments. For purposes of this SOP, a leachate outbreak is wastewater/seepage flowing directly from the covered CCR that has passed through or emerged from solid waste and contains soluble, suspended or miscible materials removed from such wastes. Seeps are flows that emerge from the ground immediately below the actual waste disposal area and that may contain leachate that is mixed with water from saturated soils or surface water infiltration.

- An inspection by a qualified person will be conducted once per week to identify any seeps and leachate outbreaks at CCR landfills and CCR surface impoundments. The inspection will include the entire perimeter of both the Green Landfill and Green Surface Impoundment as weather conditions allow at the time of the inspection. The weather conditions at the time of the inspection must be documented on the inspection form.
- Identified seeps and leachate outbreaks must be located and documented by Global Positioning Satellite (GPS) and digital photography.
- Identified seeps and leachate outbreaks must be quantified as to the amount of standing or flowing water in gallons per minute. Measurements or estimates of the impacted area in square feet must be included. Other information relevant to remediation of the outbreak or seep shall be included on the BREC inspection form.
- All information fields on the BREC inspection form shall be completed.
- Categorize the seep or leachate outbreak into one of three categories:
  - Category 1 – Leachate/seep flow is contained within a drainage ditch and pond system that flows to a KPDES permitted outfall and the outbreak or seep is readily repairable by removing the impacted area and replacing the cover dirt with compacted clay, seeded and mulched, when the soil conditions are not too wet to preclude typical construction activities or the ambient temperature is not too low to preclude typical construction activities. For purposes of this determination, readily repairable is an outbreak or seep that can reasonably be believed to be remediated by removing the impacted area and replacing the cover with compacted clay. This determination requires the judgment of the inspector based upon the size, flow, and any repeat history of the outbreak or seep. For any area where there is no visible flow and no rutting/erosion of the soil from prior flow(s),but only saturated soil, then such an area will not be

identified as a seep/leachate outbreak but will be identified and recorded as "saturated soil" in the log and monitored during subsequent weekly inspections.

  - Category 2 – Leachate/seep is contained within a drainage ditch and pond system that flows to a KPDES permitted outfall but requires further investigation and evaluation prior to any attempt at remediation or if initial remediation efforts prove to be unsuccessful.
  - Category 3 – Leachate/seep is not contained within the KPDES permitted ditch and pond system. Any areas of leachate/seep discharges that are identified must be remediated, contained or routed to the KPDES permitted ditch and pond system if the seep displays a visible flow. Actions must begin immediately to prevent an unpermitted point source discharge to a water of the United States by remediating the outbreak or seep.
- Steps to take if a Category 1 seep/leachate outbreak reappears:
  - If a Category 1 seep/leachate outbreak reappears more than 30 days after a previous repair and the flow from the seep/leachate outbreak has been reduced or the extent of the impact is reduced from the initial identification of the seep/leachate outbreak, then Big Rivers may classify the reappearance of the seep/leachate outbreak as a Category 1 seep/leachate outbreak and commence repairs per the Agreed Order (excavate, compact, seed, and mulch.)
  - For any area where there is no visible flow and no rutting/erosion of the soil from prior flow(s), but only saturated soil, then such an area will not be identified as a seep/leachate outbreak but will be identified and recorded as "saturated soil" in the log and monitored during subsequent weekly inspections.
  - Seeps/leachate outbreaks that reappear less than 30 days after a repair or that reappear at a later date with increased flow or impact area will be classified as a Category 2.
- Collect water samples for constituents listed in Table 1. A water sample will only be collected for analysis when a sufficient amount of water is flowing on the surface to collect a sample without disturbing the underlying soil. Samples will be collected once for each categorization unless there are visual changes such as color in the leachate. Seep/leachate water samples will be collected once when identified as a Category 1 and again if reclassified as a Category 2. The analysis will be performed by a laboratory certified in the State of Kentucky. The analysis must contain the chain of custody and complete analysis with QA/QC results. Results will be maintained in the Landfill operating log on-site.
- Place categorized information in the Landfill operating log.
- Corrective actions for readily repairable seeps and leachate outbreaks must begin as soon as reasonably feasible with consideration given to inclement weather patterns and soil moisture conditions.
- Remediation areas outside the KPDES permitted ditch and pond system must include the installation of sedimentation controls as found in the Storm Water Pollution Prevention Plan/Best Management Plan guidance document published by the Kentucky Division of Water. Water samples from seeps containing a visible flow shall be taken for impacted

areas outside the KPDES permitted ditch and pond system and analyzed for the constituents found in Table 1.

- Cover soil and/or special waste removed during the remediation process must be placed in an active area of a CCR landfill or reused during the remediation of the unit if practicable.
- Replacement soil must be compacted, seeded and mulched.
- Environmental Services shall evaluate and determine remediation plans for a Category 2 seep/leachate outbreak that is deemed not readily repairable based upon flow and landfill conditions. Until remediation occurs, the seep/leachate flow shall be visually monitored, conveyed to a KPDES permitted outfall, and treated as necessary to ensure compliance with KPDES discharge limits and applicable water quality standards in the receiving stream. Remediation activities required for a Category 2 outbreak will be sent to the Division of Waste Management, 300 Sower Boulevard, Frankfort, Kentucky 40601 within five (5) business days of finalizing the report.
- Category 3 seeps displaying a visual flow will be reported to the Kentucky Division of Water – Surface Water Permits Branch in Frankfort, Kentucky and the Madisonville Field Office consistent with the Section 2.12 reporting provisions of the KPDES permit for leachate/seep outbreaks. Category 3 seeps with a visual flow will also be reported to the Kentucky Division of Waste Management – Field Operations Branch in Frankfort, Kentucky and the Madisonville Field Office. Reporting of the seeps shall occur as soon as feasible after discovery of such a seep, but no later than ten (10) days after discovery. Environmental Services shall evaluate and determine remediation plans for a Category 3 seep that is deemed not readily repairable based upon flow and landfill conditions.

These protocols shall be followed at CCR units subject to the federal CCR Rule and 401 KAR Chapter 46.

- Table 1
  - From 40 CFR 257 App. III
    - Boron
    - Calcium
    - Chloride
    - Fluoride
    - pH
    - Sulfate
    - Total Dissolved Solids
  - From 40 CFR 257 App. IV
    - Antimony
    - Arsenic
    - Barium
    - Beryllium
    - Cadmium
    - Chromium
    - Cobalt

    - Fluoride
    - Lead
    - Lithium
    - Mercury
    - Molybdenum
    - Selenium
    - Thallium
    - Radium 226 and 228 combined
  - From 401 KAR 45:160
    - *Chemical Oxygen Demand
    - *Total Organic Carbon
    - *Specific Conductance
    - *Copper
    - *Nickel
    - *Zinc
    - *Iron
    - *Sodium
    - *Magnesium
    - *Potassium
    - *Bicarbonate
    - *Carbonate

**Exhibit 2**

**Northwestern Seep Collection Trench Remedy Construction Schedule**

**Green Station Existing CCR Landfill**

**Construction Schedule**

1. BREC shall initiate construction of the Northwestern Seep Collection Project (the "Project") consistent with the design plans previously reviewed by DWM no later than 90 days after entry of the Agreed Order. Notice of initiation of construction shall be provided to the Director of DWM a minimum of five (5) days prior to on-site construction activities. For purposes of this paragraph, initiation of construction occurs when earthmoving activities are commenced on the trench, and shall not include mobilization of equipment to the site, initial access work, or staging of materials. BREC agrees to provide such notice even if construction is initiated before entry of this Agreed Order.

2. BREC shall complete construction of the Project within 270 days of entry of the Agreed Order. Notice of completion of construction shall be provided to the Director of DWM within 30 days following completion of construction of the collection trench and ancillary facilities to support its operation. The notice shall conform to 40 CFR 257.98(e).

Post-construction Performance Monitoring

1. BREC shall implement a post-construction performance monitoring program as follows.
   a. The Northwestern seep shall be inspected quarterly and any flow conditions in the collection system and at the subject seep shall be recorded in the inspection log.
   b. Any visibly flowing seeps shall be sampled and analyzed for the constituents listed in the seep/leachate SOP (Exhibit 1) as needed to evaluate whether impact (above permit levels) is present or absent.
   c. A report on the operation of the collection system during each calendar quarter shall be submitted to the Director of DWM. The report shall be submitted within 30 days of the end of each calendar quarter, and placed in the landfill operating record. The report shall report on the effectiveness of the remedy.
   d. A final report on the completion of the remedy shall be submitted to the Director of DWM and placed in the operating record consistent with 40 CFR 257.98(e) for review and comment by DWM. The final report will be submitted to DWM within 60 days following the completion of four (4) consecutive quarters without identifying seepage in the targeted Northwestern seep collection area.
   e. The collection system shall be operated until seepage at the surface is not observed for four consecutive quarters and seepage into the collection system diminishes below levels that can result in a non-groundwater release. Prior to ceasing operation and reporting, concurrence shall be obtained in writing from DWM.

**Exhibit 3**

**Eastern Seep Collection Trench Remedy Construction and Post-Construction Schedule**

**Green Station Existing CCR Landfill**

**Construction Schedule**

1. BREC shall initiate construction of the Eastern Seep Collection Project (the "Project") consistent with the design plans previously reviewed by DWM no later than 120 days after entry of the Agreed Order. Notice of initiation of construction shall be provided to the Director of DWM a minimum of five (5) days prior to on-site construction activities. For purposes of this paragraph, initiation of construction occurs when earthmoving activities are commenced on the trench, and shall not include mobilization of equipment to the site, initial access work, or staging of materials. BREC agrees to provide such notice even if construction is initiated before entry of this Agreed Order.

2. BREC shall complete construction of the Project within 365 days of entry of the Agreed Order. Notice of completion of construction shall be provided to the Director of DWM within 30 days following completion of construction of the collection trench and ancillary facilities to support its operation. The notice shall conform to 40 CFR 257.98(e).

Post-construction Performance Monitoring

1. BREC shall implement a post-construction performance monitoring program as follows.
   a. The Eastern river bank seeps and collection system shall be inspected quarterly for operational conditions and for indications of continuing seepage flow. Any visibly flowing seeps shall be sampled and analyzed for the constituents listed in the seep/leachate SOP (Exhibit 1) unless prior concentrations of constituents are demonstrated to be below the applicable Water Quality Criteria.
   b. A report on the operation of the collection system during each calendar quarter shall be submitted to the Director of DWM. The quarterly system operation and seep inspection monitoring data shall be included in the report. The report shall be submitted within 30 days after the end of each calendar quarter, and placed in the operating record. The report shall address the effectiveness of the remedy.
   c. A final report on the completion of the remedy shall be submitted to the Director of DWM and placed in the operating record consistent with 40 CFR 257.98(e) for review and comment by DWM. The final report will be submitted to DWM within 60 days following the completion of four (4) consecutive quarters without identifying a flowing seep in the targeted Eastern river bank seep collection area. The final report will be placed in the operating record 30 days after approval from DWM.
   d. The collection system shall be operated until seepage at the surface is not observed for four consecutive quarters and seepage into the collection system diminishes below levels that can result in a non-groundwater release. Prior to ceasing operation and reporting, concurrence shall be obtained in writing from DWM.

**Exhibit 4**

**Groundwater Corrective Action Remedy Selection Process**

**Green Station Existing CCR Landfill**

**Selection of Remedy**

1. BREC shall conduct the public meeting required by 40 CFR 257.96(e) and 401 KAR 46:110 Section 8 regarding the groundwater and supplemental non-groundwater assessment of corrective measures within 180 days of entry of this Agreed Order. Public notice of the meeting shall be posted on BREC's CCR Rule compliance website and published in the Henderson Gleaner newspaper seven (7) to twenty-one (21) days prior to the meeting. The publication shall state the time, place and purpose of the public meeting and that the assessment of corrective measures is available for review on the BREC CCR Rule compliance website. At the public meeting, BREC shall reference the remedy selection process as set forth in this Agreed Order.
2. BREC shall evaluate the comments from the public meeting and other factors as required by 40 CFR 257.97 and 401 KAR 46:110 Section 8 and prepare a draft groundwater remedy selection report for submittal to DWM for a 30 day review and comment period. The draft report shall be submitted to DWM within 90 days following the public meeting, unless DWM approves a longer period in order for BREC to complete is evaluation.
3. BREC shall select the final groundwater corrective action remedy as soon as feasible after receipt of any DWM comments on the proposed remedy during the DWM review period.
4. The final groundwater and supplemental non-groundwater corrective action remedy selection reports shall be posted to BREC's CCR Rule compliance website in accordance with 40 CFR 257.97 and 257.107.

**Design and Construction of Remedy**

1. BREC shall design and construct the selected groundwater remedy and conduct post-construction performance monitoring pursuant to the implementation schedule set forth in the final corrective action remedy selection report.

# ATTACHMENT 10 - REMEDY SELECTION REPORTS FOR REID/HMP&L POND

# Semi-Annual Remedy Selection Progress Report

Reid/HMP&L Surface Impoundment
Sebree Generating Station
Webster County, Kentucky

Prepared for:

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

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June 2020

## Quality information

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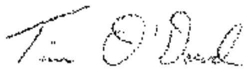
|  |  |  |  |
| Timothy P. O'Dowd, PG | Dennis P. Connair, PG | Joseph B. Suhre | Dennis P. Connair, PG |
| Project Manager | Principal Geologist | Principal Engineer | Principal Geologist |

## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
|---|---|---|---|---|---|
| 1 | June 2020 | | | | |
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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 Reid/Henderson Municipal Power & Light (Reid/HMP&L) Surface Impoundment (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 one monitoring well (MW-10) 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 Part 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 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. BREC owns Green and Reid Stations, while the City of Henderson owns HMP&L Station 2. 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 Reid/HMP&L Station Surface Impoundment is illustrated in **Figure 2**. The Surface Impoundment 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 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. Most of the central portion of the south dike was constructed on a subdued ridge.

## 2.2 Groundwater Investigation Summary

Monitoring wells were installed around the perimeter of the Unit in December 2015 prior to the implementation of the CCR Rule. These wells meet the requirements of Title 40 CFR Part 257.90 of the CCR Rule for installation of a groundwater monitoring system. Under these requirements monitoring wells must adequately represent the quality of background groundwater and groundwater representing the downgradient waste boundary. The existing wells are located along the perimeter of the footprint for the Unit. One upgradient monitoring well (MW-7) and three downgradient monitoring wells (MW-8, MW-9, and MW-10) were installed adjacent to the Unit to determine the general direction of groundwater movement and to monitor groundwater impacts. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer.

Nine rounds of Baseline groundwater sampling for Appendix III constituents was conducted between March 2016 and October 2017. Statistical evaluation of Appendix III constituents monitored for Detection monitoring indicated that statistically significant increases (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, 2019, and 2020).

As part of Assessment monitoring, upgradient and downgradient wells for the Unit were sampled for Appendix IV constituents in April, July, and September 2018. GWPS 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 – Reid/HMP&L Surface Impoundment Constituents of Concern**

| Monitoring Well (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** |

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-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 lithium in MW-110 were below the GWPS. The additional characterization data are summarized in **Table 2** below.

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

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

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

Semi-annual Assessment monitoring continued at the Unit in 2019 and 2020 in accordance with 40 CFR Part 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 upland area near the west bank of the Green River. The uppermost edge of the earthen embankment is situated at an elevation of approximately 429 feet above mean sea level (amsl). 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 Unit outflow structure and is routed, under a Kentucky Pollution Discharge and Elimination System 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 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 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. 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 425 ft., amsl at the northeast end (at MW-7), and 388 ft. amsl at the west end of the Unit (at MW-9).

Groundwater elevation data collected in October 2019 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**). Flow direction beneath the Unit is to the southwest towards an unnamed tributary to Groves Creek located west-southwest of the impoundment.

**Table 3. Reid/HMP&L Surface Impoundment – October 2019 Groundwater Elevation Data**

| Monitoring Well | Top of Casing Elevation (ft) [1] | Depth to Groundwater (ft) | Groundwater Elevation (ft, amsl) |
|---|---|---|---|
| MW-7 | 444.43 | 18.59 | 425.84 |
| MW-8 | 394.29 | 5.20 | 389.09 |
| MW-9 | 395.40 | 7.35 | 388.05 |
| MW-10 | 422.27 | 33.28 | 388.99 |

1 Reference elevation of monitoring wells surveyed by Associated Engineers, Inc., Madisonville, Kentucky, January 2015. Survey coordinates were based on the Kentucky State Plane, Kentucky Southern Zone, NAD27 datum.

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 x $10^{-6}$ to 5 x $10^{-4}$ 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

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 monitoring well MW-10 southwest of the Unit.

### 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

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. Reid/HMP&L Surface Impoundment - April 2020 Lithium Analytical Results**

| Monitoring Well (Date) | Parameter |
|---|---|
| | Lithium GWPS 0.04 (mg/L) |
| MW-7 | 0.007 |
| MW-8 | 0.03 |
| MW-9 | 0.01 |
| MW-10 | 0.49 |
| MW-110 | 0.02 |

**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 as seepage from beneath the surface impoundment, however there is currently no feasible means of directly tracing that potential under the footprint of the Unit.

### 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

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

## 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 Part 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 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. |

| Potentially Applicable Technology | Status | Description/Overview |
|---|---|---|
| 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 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
- 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 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 ACM performed for the Unit in June 2019 identified a total of five (5) 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 Part 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).

Three (3) potential corrective measures alternatives have been identified by BREC as viable options to address lithium impacts in groundwater at the Unit, including:

- Alternative #2a: CiP, ICs, and Groundwater Monitoring
- Alternative #3: CiP, ICs, Hydraulic Containment, Ex-Situ Treatment, and Groundwater Monitoring
- Alternative #4: CiP, ICs, Physical Containment, Ex-Situ Treatment, and Groundwater Monitoring

Each of the remaining 3 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 planned Reid/HMP&L 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 document the effectiveness of the corrective measures.

Alternative #2a is recommended for further evaluation.

### 3.1.2 Alternative #3 – CiP, ICs, Hydraulic Containment, Ex-Situ Treatment, 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.

Alternative #3 is recommended for further evaluation.

### 3.1.3 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 closure.

Alternative #4 is recommended for further evaluation.

## 3.2 Remedy Evaluation

Currently BREC considers the (3) potential corrective action alternatives as viable options to address groundwater impacts at the Unit, including:

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

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.

## 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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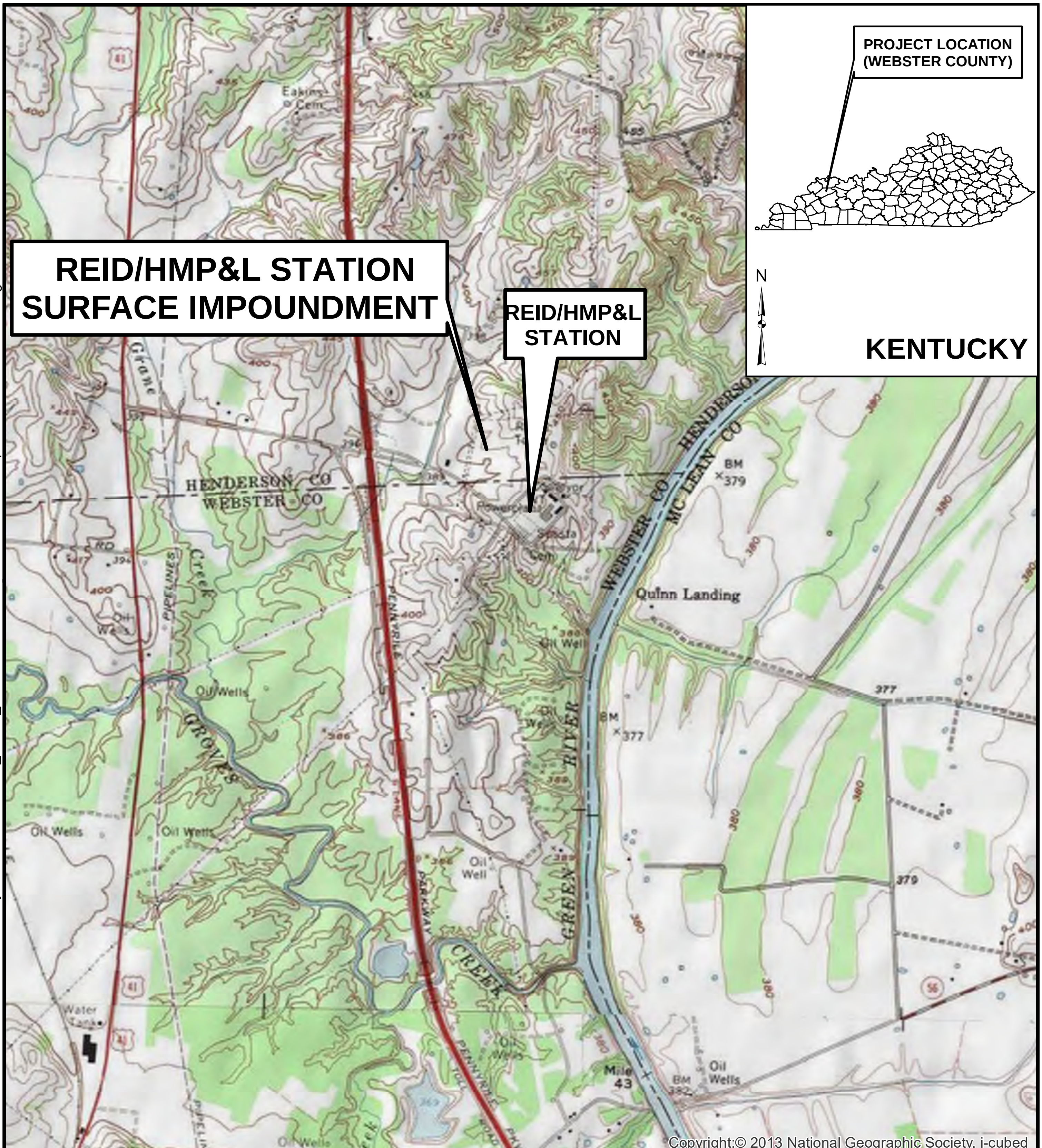


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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

*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 | |

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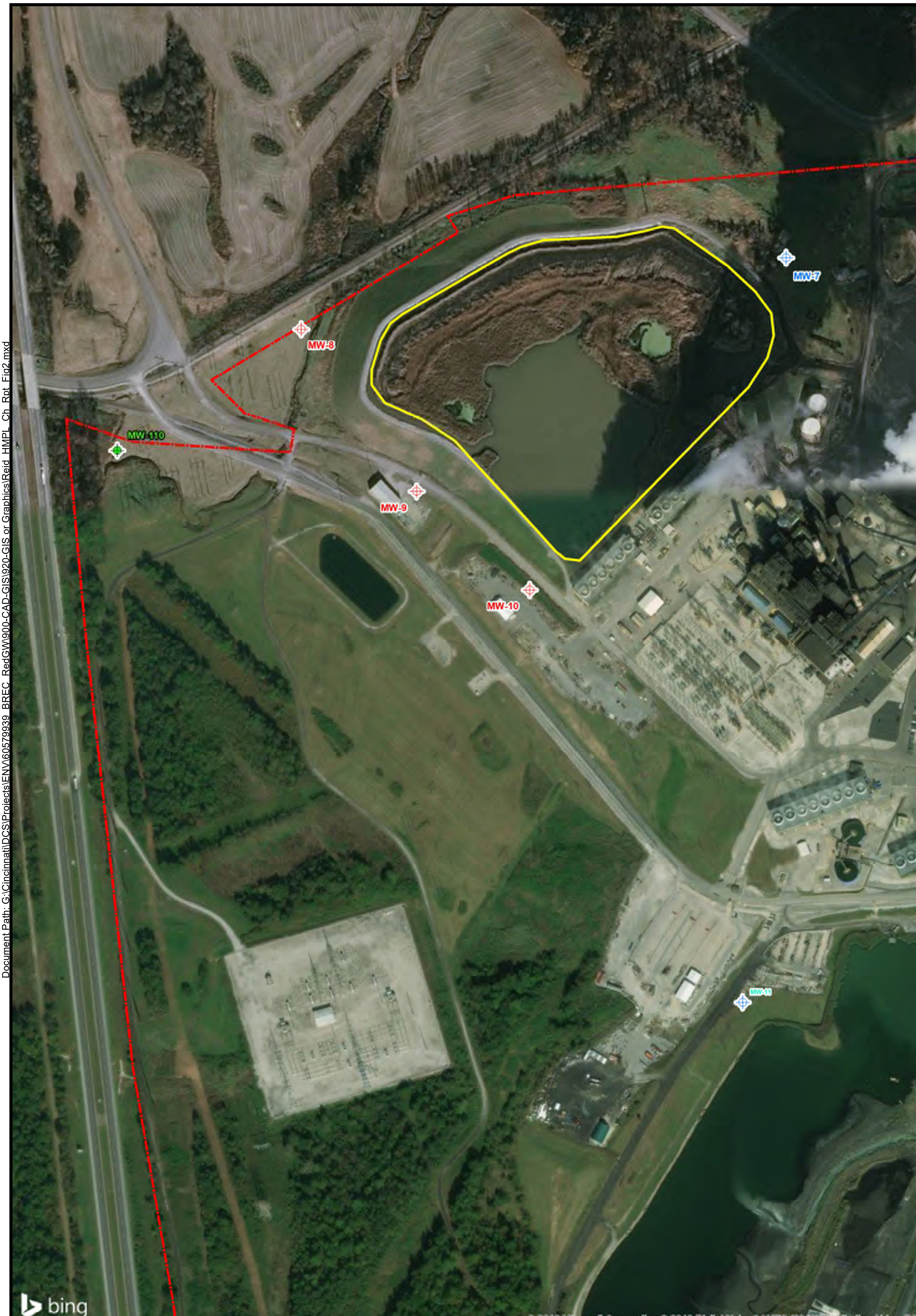


**Legend**

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

0 300 600

Feet

N

Big Rivers ELECTRIC CORPORATION

*Reid/HMPL Station*
*Webster County, Kentucky*

FIGURE 2
WELL LOCATION MAP

| | |
|---|---|
| DATE: 12/9/2019 | SCALE: 1IN = 200 FEET |
| CREATED BY: ALW | |
| JOB NO. 60602365 | |

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**Legend**

- Proposed Assessment Well
- Downgradient Monitoring Well
- Upgradient Monitoring Well
- Unit Boundary
- Property Line
- Water Table Contour (Inferred from Available Monitoring Data)
- Groundwater Flow Direction
- 389.09 Groundwater Elevation (Feet, MSL) Measured October 16, 2019

0 300 600
Feet

N

Big Rivers

*Reid/HMPL Surface Impoundment*
*Webster County, Kentucky*

FIGURE 3
GROUNDWATER SURFACE MAP
OCTOBER 2019

| | |
|---|---|
| DATE: 12/11/2019 | SCALE: 1IN = 200 FEET |
| CREATED BY: BAW | |
| JOB NO. 60579939 | |

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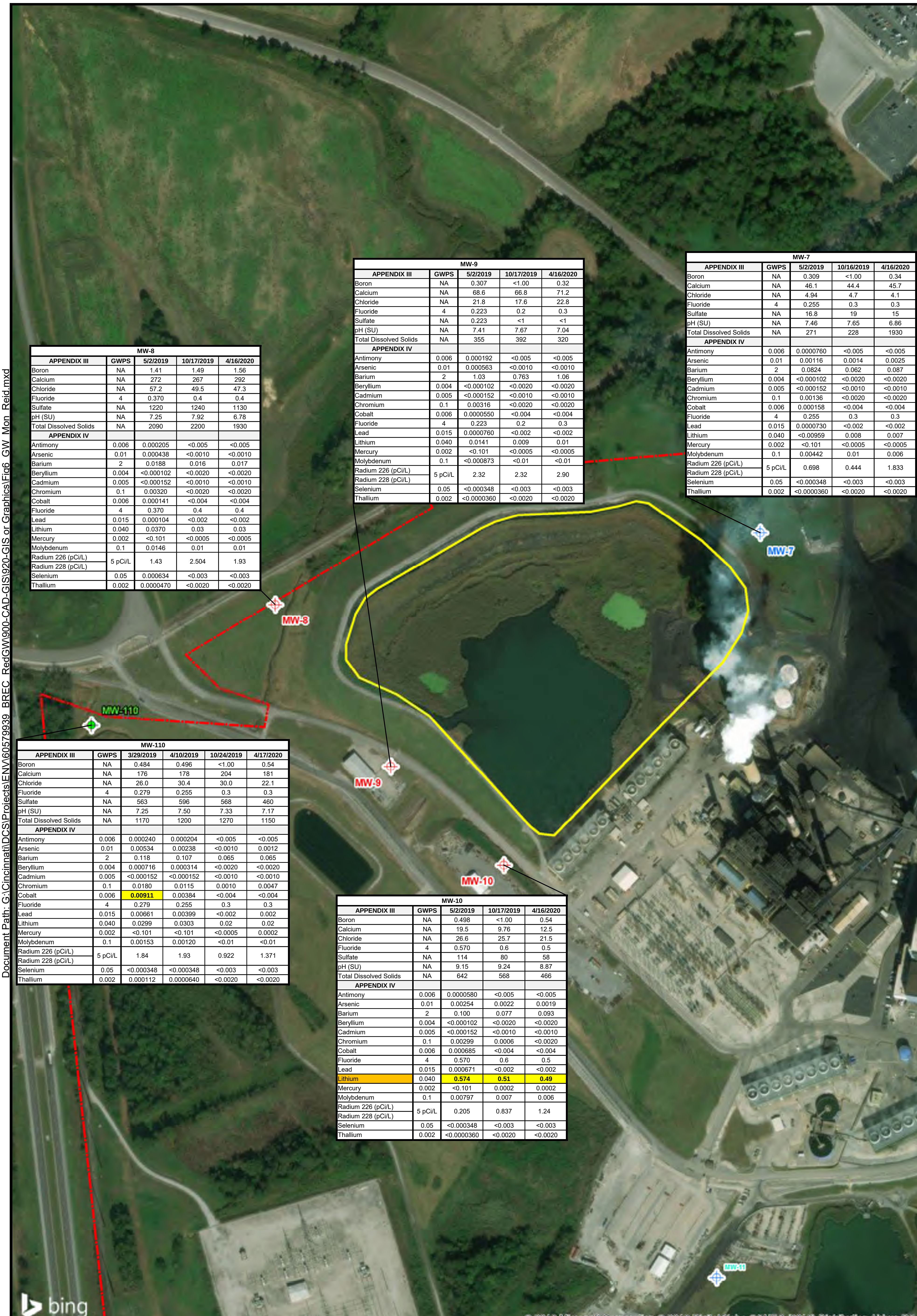


| MW-9 | | | | |
|---|---|---|---|---|
| APPENDIX III | GWPS | 5/2/2019 | 10/17/2019 | 4/16/2020 |
| Boron | NA | 0.307 | <1.00 | 0.32 |
| Calcium | NA | 68.6 | 66.8 | 71.2 |
| Chloride | NA | 21.8 | 17.6 | 22.8 |
| Fluoride | 4 | 0.223 | 0.2 | 0.3 |
| Sulfate | NA | 0.223 | <1 | <1 |
| pH (SU) | NA | 7.41 | 7.67 | 7.04 |
| Total Dissolved Solids | NA | 355 | 392 | 320 |
| APPENDIX IV | | | | |
| Antimony | 0.006 | 0.000192 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.000563 | <0.0010 | <0.0010 |
| Barium | 2 | 1.03 | 0.763 | 1.06 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00316 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.0000550 | <0.004 | <0.004 |
| Fluoride | 4 | 0.223 | 0.2 | 0.3 |
| Lead | 0.015 | 0.0000760 | <0.002 | <0.002 |
| Lithium | 0.040 | 0.0141 | 0.009 | 0.01 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | <0.000873 | <0.01 | <0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 2.32 | 2.32 | 2.90 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

| MW-7 | | | | |
|---|---|---|---|---|
| APPENDIX III | GWPS | 5/2/2019 | 10/16/2019 | 4/16/2020 |
| Boron | NA | 0.309 | <1.00 | 0.34 |
| Calcium | NA | 46.1 | 44.4 | 45.7 |
| Chloride | NA | 4.94 | 4.7 | 4.1 |
| Fluoride | 4 | 0.255 | 0.3 | 0.3 |
| Sulfate | NA | 16.8 | 19 | 15 |
| pH (SU) | NA | 7.46 | 7.65 | 6.86 |
| Total Dissolved Solids | NA | 271 | 228 | 1930 |
| APPENDIX IV | | | | |
| Antimony | 0.006 | 0.0000760 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00116 | 0.0014 | 0.0025 |
| Barium | 2 | 0.0824 | 0.062 | 0.087 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00136 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.000158 | <0.004 | <0.004 |
| Fluoride | 4 | 0.255 | 0.3 | 0.3 |
| Lead | 0.015 | 0.0000730 | <0.002 | <0.002 |
| Lithium | 0.040 | <0.00959 | 0.008 | 0.007 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | 0.00442 | 0.01 | 0.006 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 0.698 | 0.444 | 1.833 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

| MW-8 | | | | |
|---|---|---|---|---|
| APPENDIX III | GWPS | 5/2/2019 | 10/17/2019 | 4/16/2020 |
| Boron | NA | 1.41 | 1.49 | 1.56 |
| Calcium | NA | 272 | 267 | 292 |
| Chloride | NA | 57.2 | 49.5 | 47.3 |
| Fluoride | 4 | 0.370 | 0.4 | 0.4 |
| Sulfate | NA | 1220 | 1240 | 1130 |
| pH (SU) | NA | 7.25 | 7.92 | 6.78 |
| Total Dissolved Solids | NA | 2090 | 2200 | 1930 |
| APPENDIX IV | | | | |
| Antimony | 0.006 | 0.000205 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.000438 | <0.0010 | <0.0010 |
| Barium | 2 | 0.0188 | 0.016 | 0.017 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00320 | <0.0020 | <0.0020 |
| Cobalt | 0.006 | 0.000141 | <0.004 | <0.004 |
| Fluoride | 4 | 0.370 | 0.4 | 0.4 |
| Lead | 0.015 | 0.000104 | <0.002 | <0.002 |
| Lithium | 0.040 | 0.0370 | 0.03 | 0.03 |
| Mercury | 0.002 | <0.101 | <0.0005 | <0.0005 |
| Molybdenum | 0.1 | 0.0146 | 0.01 | 0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 1.43 | 2.504 | 1.93 |
| Selenium | 0.05 | 0.000634 | <0.003 | <0.003 |
| Thallium | 0.002 | 0.0000470 | <0.0020 | <0.0020 |

| MW-110 | | | | | |
|---|---|---|---|---|---|
| APPENDIX III | GWPS | 3/29/2019 | 4/10/2019 | 10/24/2019 | 4/17/2020 |
| Boron | NA | 0.484 | 0.496 | <1.00 | 0.54 |
| Calcium | NA | 176 | 178 | 204 | 181 |
| Chloride | NA | 26.0 | 30.4 | 30.0 | 22.1 |
| Fluoride | 4 | 0.279 | 0.255 | 0.3 | 0.3 |
| Sulfate | NA | 563 | 596 | 568 | 460 |
| pH (SU) | NA | 7.25 | 7.50 | 7.33 | 7.17 |
| Total Dissolved Solids | NA | 1170 | 1200 | 1270 | 1150 |
| APPENDIX IV | | | | | |
| Antimony | 0.006 | 0.000240 | 0.000204 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00534 | 0.00238 | <0.0010 | 0.0012 |
| Barium | 2 | 0.118 | 0.107 | 0.065 | 0.065 |
| Beryllium | 0.004 | 0.000716 | 0.000314 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.0180 | 0.0115 | 0.0010 | 0.0047 |
| Cobalt | 0.006 | **0.00911** | 0.00384 | <0.004 | <0.004 |
| Fluoride | 4 | 0.279 | 0.255 | 0.3 | 0.3 |
| Lead | 0.015 | 0.00661 | 0.00399 | <0.002 | 0.002 |
| Lithium | 0.040 | 0.0299 | 0.0303 | 0.02 | 0.02 |
| Mercury | 0.002 | <0.101 | <0.101 | <0.0005 | 0.0002 |
| Molybdenum | 0.1 | 0.00153 | 0.00120 | <0.01 | <0.01 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 1.84 | 1.93 | 0.922 | 1.371 |
| Selenium | 0.05 | <0.000348 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | 0.000112 | 0.0000640 | <0.0020 | <0.0020 |

| MW-10 | | | | |
|---|---|---|---|---|
| APPENDIX III | GWPS | 5/2/2019 | 10/17/2019 | 4/16/2020 |
| Boron | NA | 0.498 | <1.00 | 0.54 |
| Calcium | NA | 19.5 | 9.76 | 12.5 |
| Chloride | NA | 26.6 | 25.7 | 21.5 |
| Fluoride | 4 | 0.570 | 0.6 | 0.5 |
| Sulfate | NA | 114 | 80 | 58 |
| pH (SU) | NA | 9.15 | 9.24 | 8.87 |
| Total Dissolved Solids | NA | 642 | 568 | 466 |
| APPENDIX IV | | | | |
| Antimony | 0.006 | 0.0000580 | <0.005 | <0.005 |
| Arsenic | 0.01 | 0.00254 | 0.0022 | 0.0019 |
| Barium | 2 | 0.100 | 0.077 | 0.093 |
| Beryllium | 0.004 | <0.000102 | <0.0020 | <0.0020 |
| Cadmium | 0.005 | <0.000152 | <0.0010 | <0.0010 |
| Chromium | 0.1 | 0.00299 | 0.0006 | <0.0020 |
| Cobalt | 0.006 | 0.000685 | <0.004 | <0.004 |
| Fluoride | 4 | 0.570 | 0.6 | 0.5 |
| Lead | 0.015 | 0.000671 | <0.002 | <0.002 |
| Lithium | 0.040 | **0.574** | **0.51** | **0.49** |
| Mercury | 0.002 | <0.101 | 0.0002 | 0.0002 |
| Molybdenum | 0.1 | 0.00797 | 0.007 | 0.006 |
| Radium 226 (pCi/L)<br>Radium 228 (pCi/L) | 5 pCi/L | 0.205 | 0.837 | 1.24 |
| Selenium | 0.05 | <0.000348 | <0.003 | <0.003 |
| Thallium | 0.002 | <0.0000360 | <0.0020 | <0.0020 |

**Legend**

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

N

0 300 600
Feet

Big Rivers

*Reid/HMPL Surface Impoundment*
*Webster County, Kentucky*

FIGURE 4
GROUNDWATER CONDITIONS MAP
2019-2020 ANALYTICAL RESULTS

| | |
|---|---|
| DATE: 6/10/2020 | SCALE: 1IN = 200 FEET |
| CREATED BY: SEL | |
| JOB NO. 60619822 | |

AECOM
525 Vine Street
Cincinnati, OH 45202
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# REMEDY SELECTION PROGRESS REPORT

## REID/HMP&L SURFACE IMPOUNDMENT
## SEBREE GENERATING STATION
## WEBSTER COUNTY, KENTUCKY

**December 9, 2019**

*Prepared For:*

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

*Prepared by:*


AECOM Technical Services

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Project No.: 60619822

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# 1.0 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) Section 257.97, Big Rivers Electric Cooperation (BREC) is in the process of selecting a remedy for groundwater impacts at the Reid/Henderson Municipal Power & Light (Reid/HMP&L) Surface Impoundment (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 one monitoring well (MW-10) 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 Section 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 Section 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 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 following sections 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).

# 2.0 SITE BACKGROUND

## 2.1 Site Description

BREC 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. BREC owns Green and Reid Stations, while the City of Henderson owns HMP&L Station 2. 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 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. Most of the central portion of the south dike was constructed on a subdued ridge.

## 2.2 Groundwater Investigation Summary

Monitoring wells were installed around the perimeter of the Unit 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. Under these requirements monitoring wells must adequately represent the quality of background groundwater and groundwater representing the downgradient waste boundary. The existing wells are located along the perimeter of the footprint for the Unit. One upgradient monitoring well (MW-7) and three downgradient monitoring wells (MW-8, MW-9, and MW-10) were installed adjacent to the Unit to determine the general direction of groundwater movement and to monitor groundwater impacts. The monitoring wells were installed in the uppermost saturated portion of the sandstone bedrock aquifer.

Nine rounds of Baseline groundwater sampling was conducted between March 2016 and October 2017. Statistical evaluation of Appendix III constituents monitored for Detection monitoring indicated that statistically significant increases (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).

As part of Assessment monitoring, upgradient and downgradient wells for the Unit were sampled for Appendix IV constituents in April, July, and September 2018. GWPS were established for Assessment monitoring of the Appendix IV constituents, and statistical evaluation indicated exceedances of GWPSs at SSLs, as detailed in **Table 1** below.

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

| Monitoring Well (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** |

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-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 lithium in MW-110 were below the GWPS. The additional characterization data are summarized in **Table 2** below.

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

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

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

## 2.3 Conceptual Site Model

A Conceptual Site Model (CSM) has been developed to support the remedy selection process for groundwater corrective action at the Unit.

### 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, the Ohio, the Kentucky, the 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 clastics and carbonates consisting primarily of sandstone and shale. The unconsolidated materials also include fill, silty and clayey residuum, and minor amounts of sandy, and clayey channel fill alluvium.

The Unit is located on upland area near the west bank of the Green River. The uppermost edge of the earthen embankment is situated at an elevation of approximately 429 feet above mean sea level (amsl). 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 Unit outflow structure and is routed, under a Kentucky Pollution Discharge and Elimination System permit, to the Green River.

### 2.3.2 Geology

The Unit lies in the Western Kentucky Coalfields section of the Interior Low Plateaus physiographic province, 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 in places 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 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. At the base of the Shelburn Formation is the Providence Limestone Member, consisting of two distinct limestone beds separated by a sandy shale, but this member is absent in much of the area 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 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 413.4 ft., amsl at the northeast end (at MW-7), and 341.6 ft. amsl at the west end of the Unit (at MW-8). Flow direction beneath the Unit 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 $3 \times 10^{-6}$ to $5 \times 10^{-4}$ 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 (COC)

As discussed above, a single Appendix IV COC (lithium) was detected at concentrations exceeding GWPS in one monitoring well location (MW-10). As a result, the corrective measure evaluation is confined to the area adjacent to this monitoring well.

### 2.3.5 Potential Receptors/Exposure 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 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 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).

## 2.4 Interim Corrective Measures

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

## 2.5 Assessment of Corrective Measures Summary

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).

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 in **Table 3** 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. |
| 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. |

| Potentially Applicable Technology | Status | Description/Overview |
|---|---|---|
| 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
- 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 presented in the ACM is considered 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.

# 3.0 REMEDY SELECTION PROGRESS

Five corrective measure alternatives were identified during the ACM process for potential implementation at the Unit to address groundwater impacts. Each corrective measure alternative consists of one or more corrective measures technologies assembled into a strategy for the groundwater remedy. Each alternative is discussed in more detail below.

## 3.1 Potential Corrective Action Alternatives

### 3.1.1 Alternative #1 – No Action and Groundwater Monitoring

Alternative #1 consists of taking no action to address groundwater impacts at the Unit. Under the No Action alternative, no corrective action would be implemented to remove, control, mitigate, or minimize exposure to impacted groundwater. The No Action alternative establishes a baseline or reference point against which each of the corrective measure alternatives is compared.

Since Alternative #1 would not attain the CAOs for the Unit, this alternative would not likely be acceptable to stakeholders. Therefore, Alternative #1 is <u>not</u> recommended for further consideration.

### 3.1.2 Alternative #2a – Closure in Place (CiP), Institutional Controls (ICs), and Groundwater Monitoring

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

- CiP source control, which consists of planned Reid/HMP&L 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 document the effectiveness of the corrective measures.

Alternative #2a is recommended for further evaluation.

### 3.1.3 Alternative #2b – Closure by Removal (CbR), ICs, and Groundwater Monitoring

Alternative #2b as currently envisioned would be similar to Alternative #2a except that CiP is replaced by CbR, which consists of excavation and removal of the Unit. Given that Alternative #2b is likely cost prohibitive, this alternative is <u>not</u> recommended for further consideration.

### 3.1.4 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.

Alternative #3 is recommended for further evaluation.

### 3.1.5 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

Alternative #4 is recommended for further evaluation.

## 3.2 Remedy Evaluation

Currently BREC considers three (3) potential corrective action alternatives as viable options to address groundwater impacts at the Unit, including:

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

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.

# 4.0 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 June 2020.

## 5.0 REFERENCES

AECOM, 2018. Annual Groundwater Monitoring and Corrective Action Report, 2016-2017; Reid/HMP&L Station Surface Impoundment, Webster County, Kentucky.

AECOM, 2019. Annual Groundwater Monitoring and Corrective Action Report, 2018; Reid/HMP&L Station Surface Impoundment, Webster County, Kentucky.

Associated Engineers 2016. Hydrologic and Hydraulic Capacity Assessment and Initial Inflow Design Flood Control System Plan.

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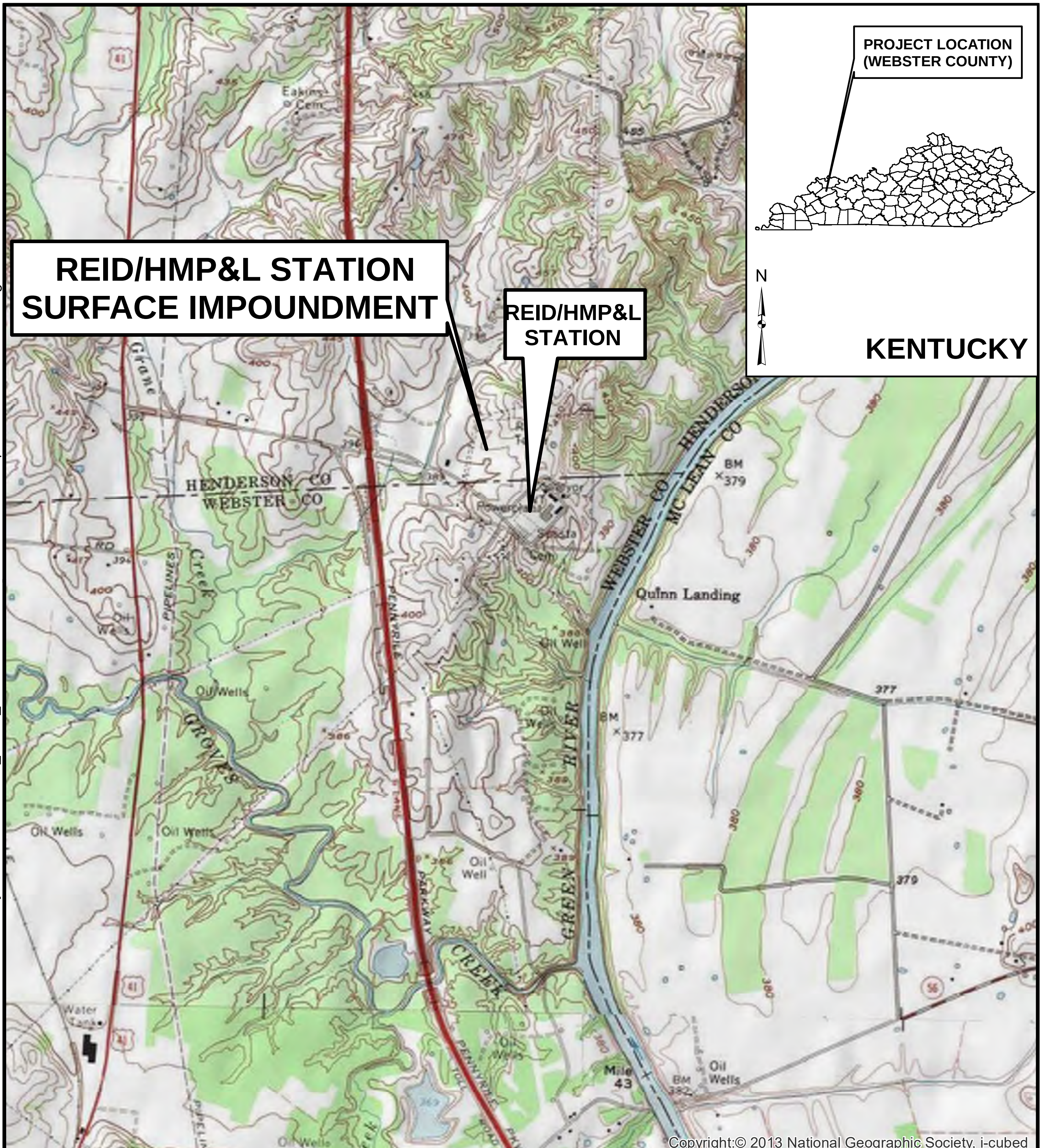
# Figures

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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

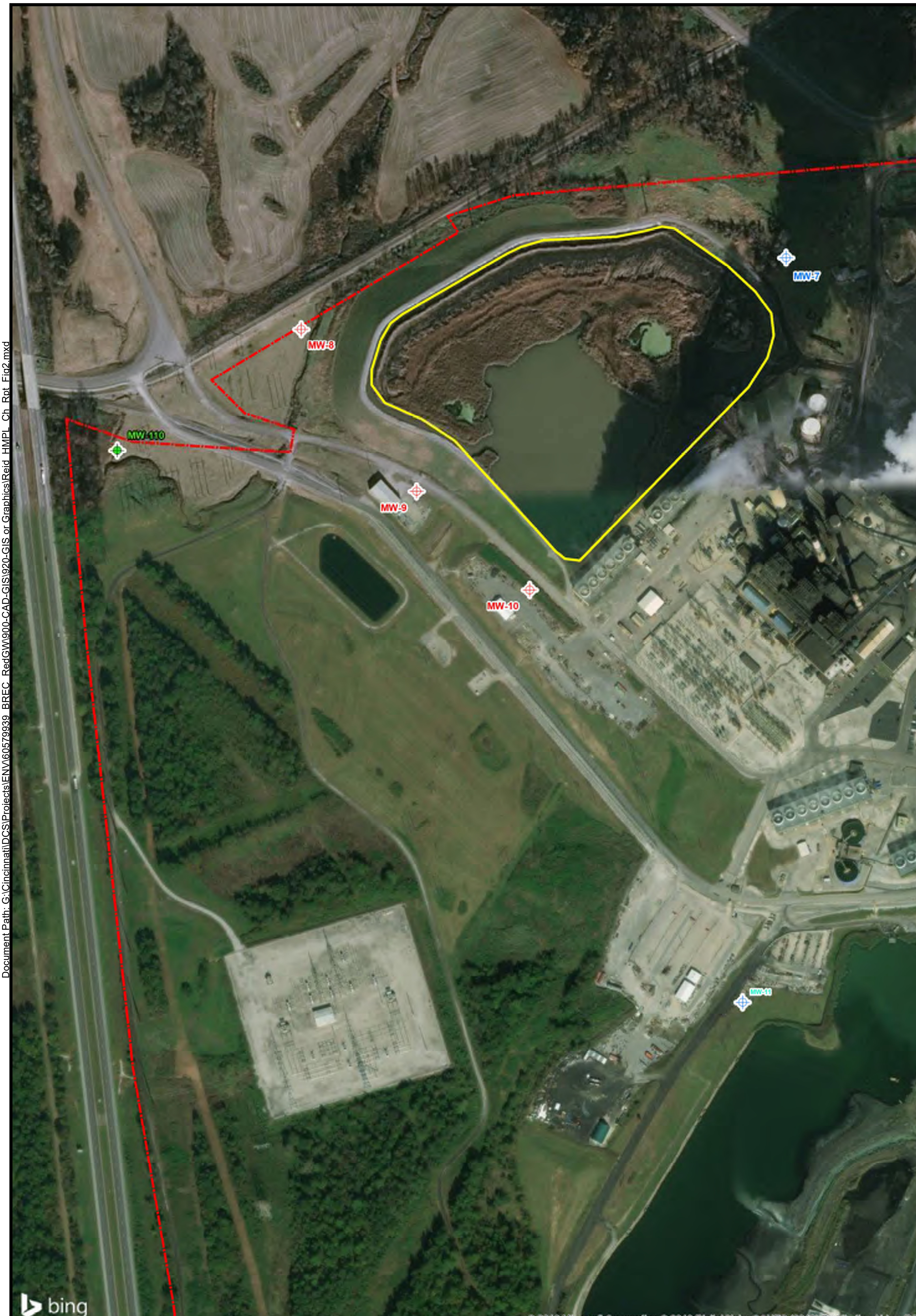
N

Big Rivers ELECTRIC CORPORATION

*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 | |

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**Legend**

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

0 300 600
Feet

N

Big Rivers

*Reid/HMPL Station*
*Webster County, Kentucky*

FIGURE 2
WELL LOCATION MAP

| | |
|---|---|
| DATE: 12/9/2019 | SCALE: 1IN = 200 FEET |
| CREATED BY: ALW | |
| JOB NO. 60602365 | |

# ATTACHMENT 11 - STRUCTURAL STABILITY ASSESSMENT (OCTOBER 2016)

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

# Green Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Structural Stability Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
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**Project ID: 160028A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Structural Stability Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Green Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0980 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

Conduct initial structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

1. Stable foundations and abutments;

2. Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

3. Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

4. Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms

of slope protection;

5. A single spillway or a combination of spillways configured as specified in the final rule. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in the final rule and all spillways must be either of non-erodible construction and designed to carry sustained flows; or earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected. The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or 1000-year flood for a significant hazard potential CCR surface impoundment; or 100-year flood for a low hazard potential CCR surface impoundment;

6. Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and

7. For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

**From: VI. Development of the Final Rule - Technical Requirements**

In order to ensure the proper upkeep and operation of the CCR unit, the owner or operator must demonstrate that the CCR surface impoundment has been designed, constructed, operated and maintained to provide structural stability. Specifically, the final rule requires the owner or operator to demonstrate that the design, construction, operation, and maintenance of the CCR surface impoundment is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and water that can be impounded therein. Specifically, the final rule focuses on the critical structural aspects of the CCR surface impoundment that EPA identified in the proposed rule, and identifies the minimum elements that a professional engineer must provide engineering details on or otherwise address. Consistent with the proposal, these demonstrations must be certified by a qualified professional engineer.

In addition to implementing adequate slope protection against erosion, which is a structural stability requirement applicable to all CCR units, the owner or operator of a CCR surface impoundment exceeding the specified size threshold (height of five feet or more and a storage volume of 20 acre-feet or more; or a height of 20 feet or more) must demonstrate that the unit, including any vertical and lateral expansions, is constructed with ‘‘stable foundations and abutments.’’ A stable foundation is an essential element of surface impoundment construction and prevents differential settlement of the embankment which can result in adverse internal stresses with the embankment cross-section.

Consistent with general engineering construction methodologies, the structural stability assessment also requires the owner or operator to determine whether the CCR surface impoundment has been mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit. Compaction of a dike or embankment is considered essential, as the compaction of soils leads to an increase in density and subsequently strength. Soil mechanics theory has established that the density of a soil corresponds to the moisture content and strength of the soil. The rule requires the owner or operator make this determination for all dikes of a CCR surface impoundment.

The owner or operator must also design, construct, operate, and maintain the CCR surface impoundment spillway or spillways with appropriate material so as to prevent the degradation of the spillway, as well as to ensure that the CCR surface impoundment has adequate spillway capacity to manage the outflow from a specific inflow design flood. In addition, a demonstration must be made that the CCR surface impoundment has been designed, constructed, operated, and maintained with inflow design flood controls and/or spillway capacity to manage peak discharge during and following inflow design floods. This demonstration is required to ensure the CCR surface impoundments will have adequate hydrologic and hydraulic capacity to prevent such failures as overtopping and excessive internal seepage and erosion. Spillways must be designed to withstand discharge from the inflow design flood without losing their structural form and leading to discharge issues, such as erosion or overtopping of the embankment. This requirement is covered in more detail in the hydrologic and hydraulic capacity requirements for CCR surface impoundments section of this rule.

EPA is not requiring a facility to include any demonstration relating to the potential for rapid, or sudden, drawdown loading condition. Rapid or sudden drawdown is a condition in earthen embankments in which the embankment becomes saturated through seepage in an extended high pool elevation in the reservoir. A threat to the embankment emerges when the reservoir pool is drawn down or lowered at a rate significantly higher than the excess poor water pressure within the embankment can diminish. Typically, rapid drawdown scenarios are considered for embankments with reservoirs used for water supply and management, emergency reservoirs, or agricultural supply, in which the reservoir is rapidly discharged from the structure.

A second consideration regarding rapid drawdown, however, is the rapid drawdown of a water body adjacent to the slope of the CCR surface impoundment which may periodically inundate the slope. Many CCR surface impoundments are located in areas in which the downstream slope of the CCR surface impoundment runs down to a lake, stream, or river. In such instances, rapid drawdown must be considered for the stability of the downstream slope of the embankment in the event of a rapid drawdown in the lake, stream, or river pool elevation or stage. Because the water ponded against the downstream slope of the CCR surface impoundment provides a stabilizing load on the slope of the CCR surface impoundment, the rapid or gradual loss of this stabilizing force must be considered in the analysis of the CCR surface impoundment. The rule, therefore, requires that existing and new CCR surface impoundments and any lateral expansions of such units with a downstream slope that can be inundated by an adjacent water body, such as rivers, streams, or lakes, be constructed with downstream slopes that will maintain structural integrity in events of low pool or rapid drawdown of the adjacent water body. This ensures that the structural integrity of the downstream slope of the CCR surface impoundment will be maintained, even though the conditions of an adjacent surface water body may be outside the owner or operator's control.

**Description of Impoundment**

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years and is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant 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. The toe of the outboard slope intersected a lower drainage area. 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.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 16 feet and 46 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 394 feet and 408 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 172,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 981,000 cubic yards (approximate water volume is 172,000 cubic yards and approximate CCR volume is 809,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of two corrugated steel pipes, each 24 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

## Results of the Initial Structural Stability Assessment

The initial structural stability assessment has been completed and documents whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. Slope stability analyses were performed using Rocscience Inc. Slide geotechnical software. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods.

The assessment documents whether the CCR unit has been designed, constructed, operated, and maintained with:

1. Stable foundations and abutments;

   The 2015 Annual Inspection indicates that the Green CCR impoundment exhibits stable foundations and abutments. No related deficiencies were observed during the annual inspection.

2. Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

   The 2015 Annual Inspection indicates the Green CCR impoundment exhibits mostly adequate slope protection from erosion, wave action and any effects if sudden drawdown could occur. No related deficiencies were observed during the annual inspection.

3. Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

   Quality assurance and/or testing reports describing the compaction methods and results during embankment construction are not available. A geotechnical exploration was performed to meet the requirements of 40 CFR §257.73(e); the exploration included Standard Penetration Testing (SPT) and acquisition of undisturbed soil samples. Based on the field results and laboratory analyses, the materials within the embankment are sufficient to withstand the anticipated loading conditions.

4. Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

   The 2015 Annual Inspection indicates the Green CCR impoundment embankment exhibits vegetation mostly greater a height of six inches above the slope of the dike. The Utility Solid Waste Activities Group, et al. has petitioned the USEPA to remand this requirement from the final rule because it is not practical and in remanding the provision, there is no reasonable probability of adverse effects on human health or the environment. USEPA has agreed that the requirement should be remanded.

5. A single spillway or a combination of spillways configured as specified in the final rule. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in the final rule and all spillways must be either of non-erodible construction and designed to carry sustained flows; or earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected. The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or 1000-year flood for a significant hazard potential CCR surface impoundment; or 100-year flood for a low hazard potential CCR surface impoundment;

   The impoundment has a single spillway structure. The spillway is comprised of two 30-inch corrugated metal pipes with a dual-pipe concrete headwall. The impoundment was analyzed for a 1000-year/24-hour storm event using SCS methodologies and a Type II rainfall distribution. Precipitation depth during the design storm was acquired from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates database. Based on the analysis, the spillway structure can manage the flow from the design storm without overtopping the embankment. The analysis was based on the current impoundment configuration, storm water flows, process water flows, and contents volume.

6. Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and

   The 2015 Annual Inspection indicates the hydraulic structures underlying the base of the Green impoundment or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure. No related deficiencies were observed during the annual inspection.

7. For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

   Due to the configuration and location of the impoundment, stability is not anticipated to be significantly affected by low river pool conditions. Although a portion of the downstream slope of the impoundment embankment is located below the 100-year flood elevation of the Green River and may experience encroachment of the adjacent water body during a flood event, stability is not anticipated to be affected by sudden drawdown. A rapid drawdown analysis was completed to assess the downstream slope of the impoundment during such an event and the analysis resulted in an acceptable factor of safety demonstrating that the slope will maintain structural stability during a sudden drawdown.

**<u>Sources of Information</u>**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Green CCR Impoundment Initial Structural Stability Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Structural Stability Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb

David A. Lamb, P.E.

State of Kentucky License No. 17822

STATE OF KENTUCKY DAVID A. LAMB 17822 LICENSED PROFESSIONAL ENGINEER

Date: 10/11/16


Attachment A. Aerial Photo of the Green CCR Surface Impoundment


Attachment B. Topographic Map showing the Green CCR Surface Impoundment

Big Rivers
ELECTRIC CORPORATION
Your Touchstone Energy® Cooperative

# Green Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

**Project ID: 160028A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Green Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0980 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
>
> 3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

**From: VI. Development of the Final Rule - Technical Requirements**

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface

impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

<u>The Calculated Liquefaction Factor of Safety</u>

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

<u>Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment</u>

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

## **<u>Description of Impoundment</u>**

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit has been in place for 40 plus years. The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant 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. The toe of the outboard slope intersected a lower drainage area. 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.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 16 feet and 46 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 394 feet and 408 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 172,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 981,000 cubic yards (approximate water volume is 172,000 cubic yards and approximate CCR volume is 809,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of two corrugated steel pipes, each 30 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

**Calculated Safety Factors**

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Green CCR impoundment are attached to this report.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 1.800

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 1.800

3. The calculated seismic factor of safety equals: 1.002

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.800

**Sources of Information**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Green CCR Impoundment Initial Safety Factor Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.
State of Kentucky License No. 17822

Date: 10/11/16


Attachment A. Aerial Photo of the Green CCR Surface Impoundment


Attachment B.  Topographic Map showing the Green CCR Surface Impoundment

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |

| | |
|---|---|
| 170.48 | 366.698 |

## Material Boundary

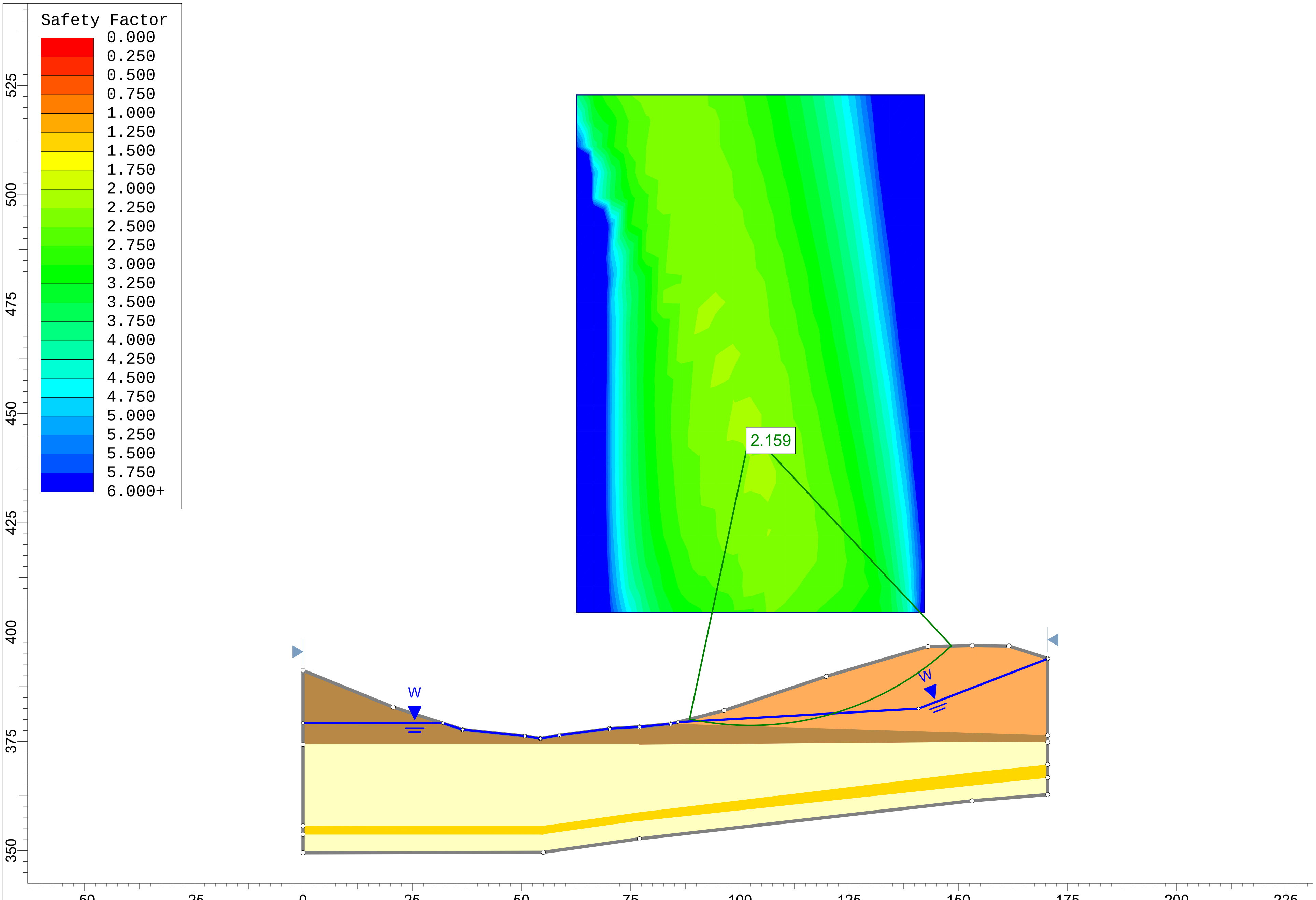
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | |
|---|---|
| Project | BREC Green Station CCR Surface Impoundment |
| Analysis Description | Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc |
| Date | 9/5/2016, 3:43:18 PM |
| File Name | GR-1.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy lean clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 165.719 | 395.483 |
| 170.48 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |

| | |
|---|---|
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

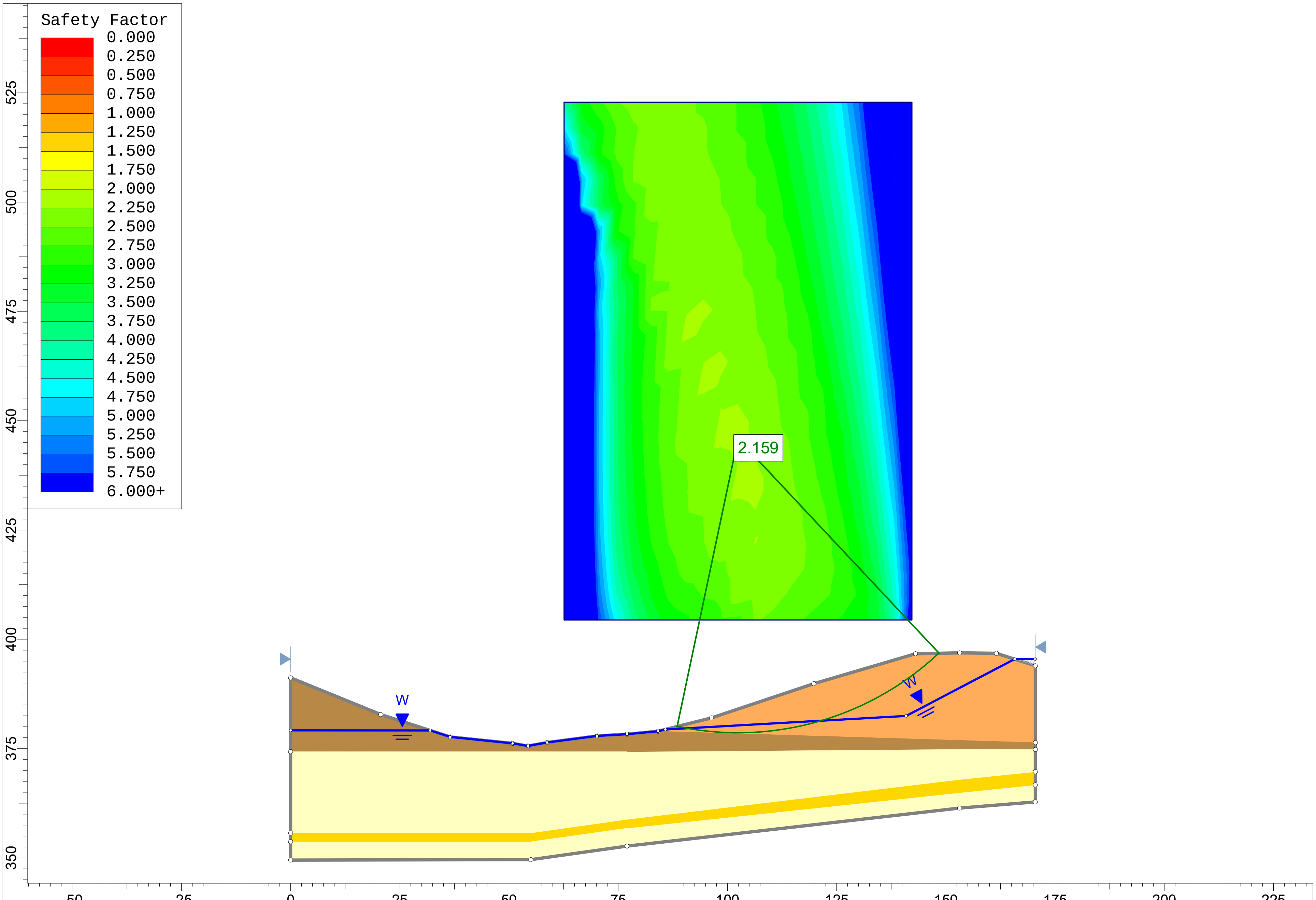
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc |
| Date 9/5/2016, 3:43:18 PM | | File Name GR-1 Surcharge.slim | |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Seismic Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

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| 50.832 | 376.221 |
| 54.305 | 375.6 |

| | |
|---|---|
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| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

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| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
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| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

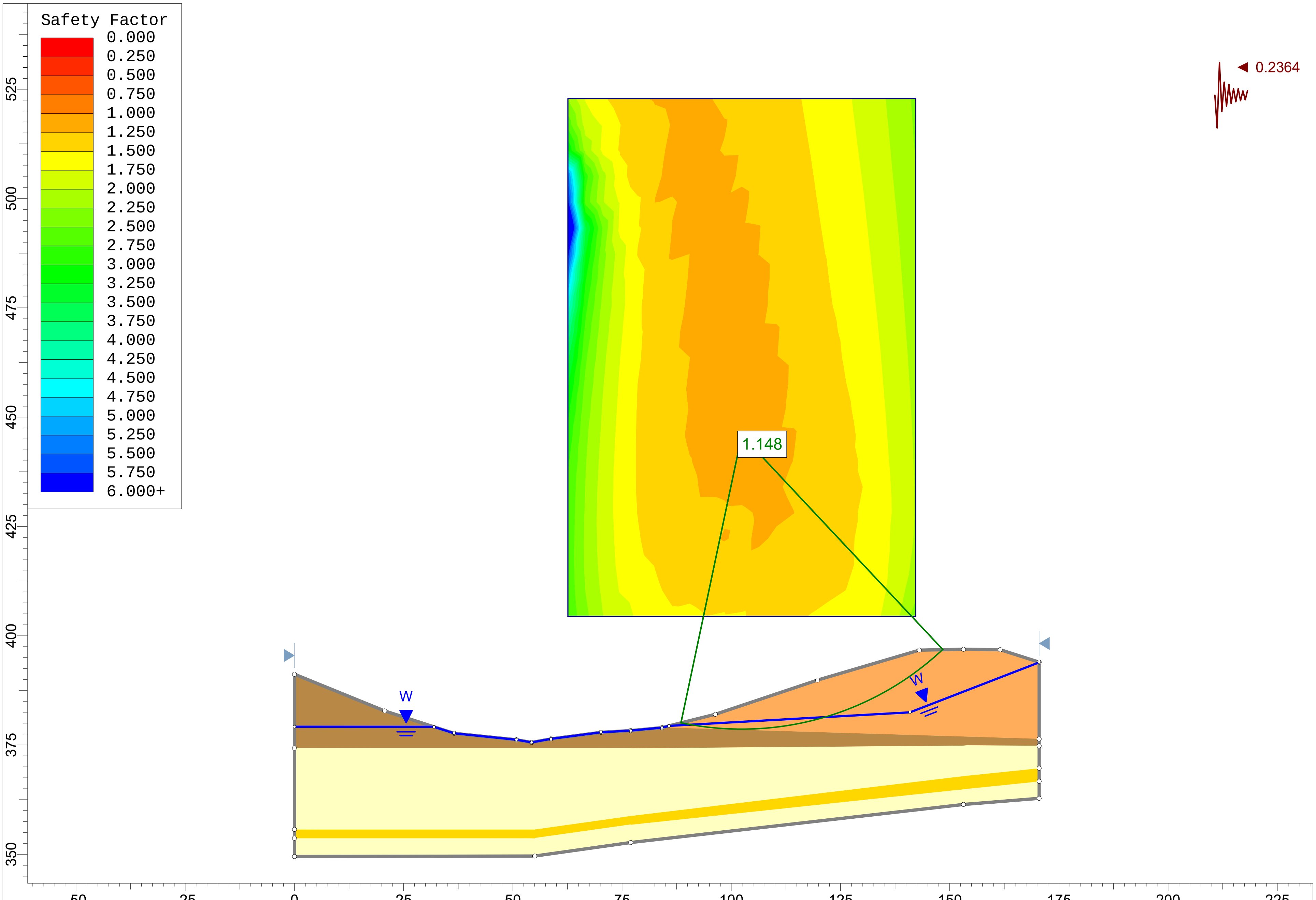
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Seismic Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc |
| Date 9/5/2016, 3:43:18 PM | | File Name GR-1 Seis.slim | |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

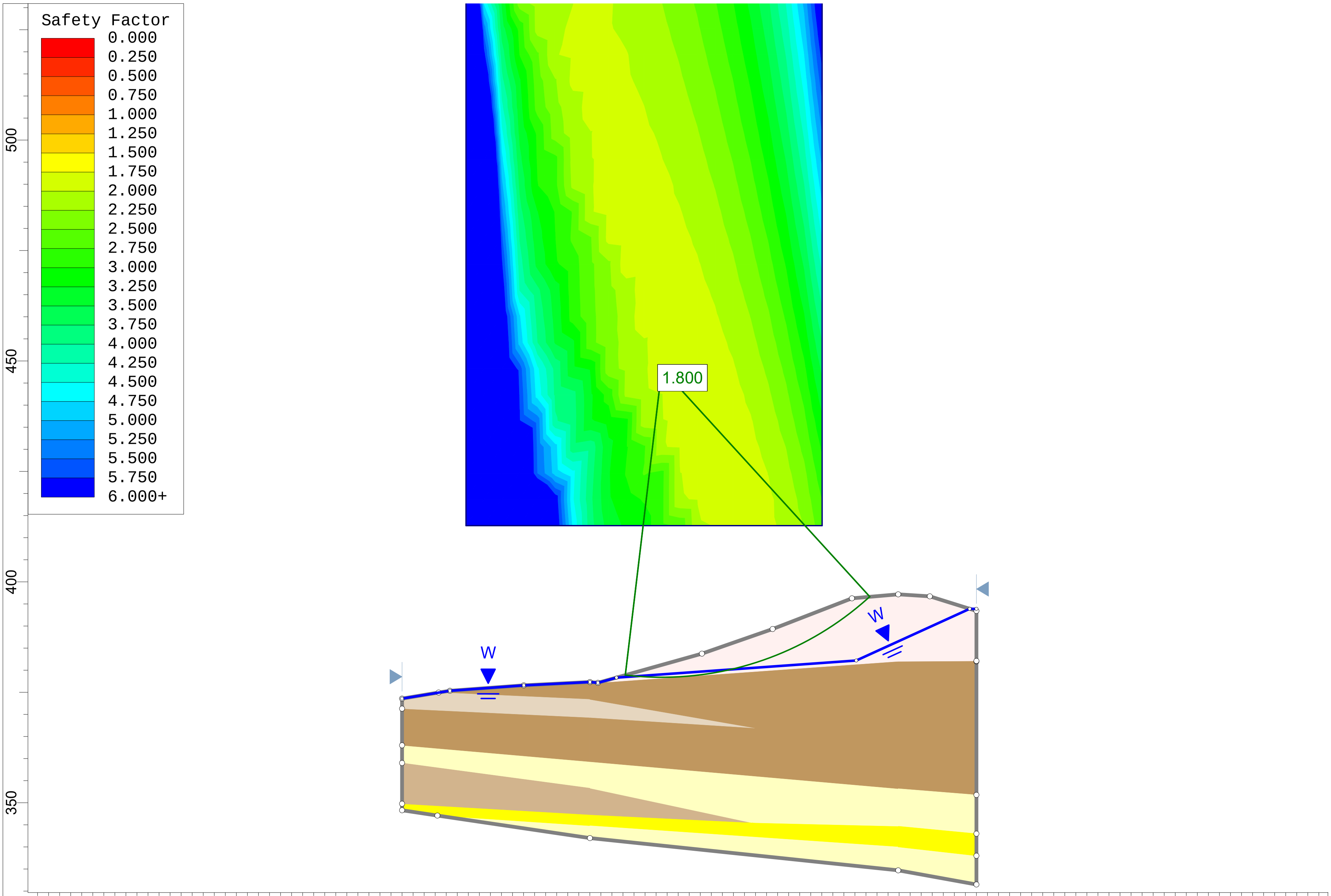
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| Project | BREC Green Station CCR Surface Impoundment | | |
|---|---|---|---|
| Analysis Description | Cross Section GR-2 Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company: Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | File Name | GR-2.slim |

SLIDEINTERPRET 6.039

# *Slide Analysis Information*

# *BREC Green Station CCR Surface Impoundment*

## *Project Summary*

File Name: GR-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## *General Settings*

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## *Analysis Options*

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## *Groundwater Analysis*

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 123.45 | 395.483 |
| 130 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

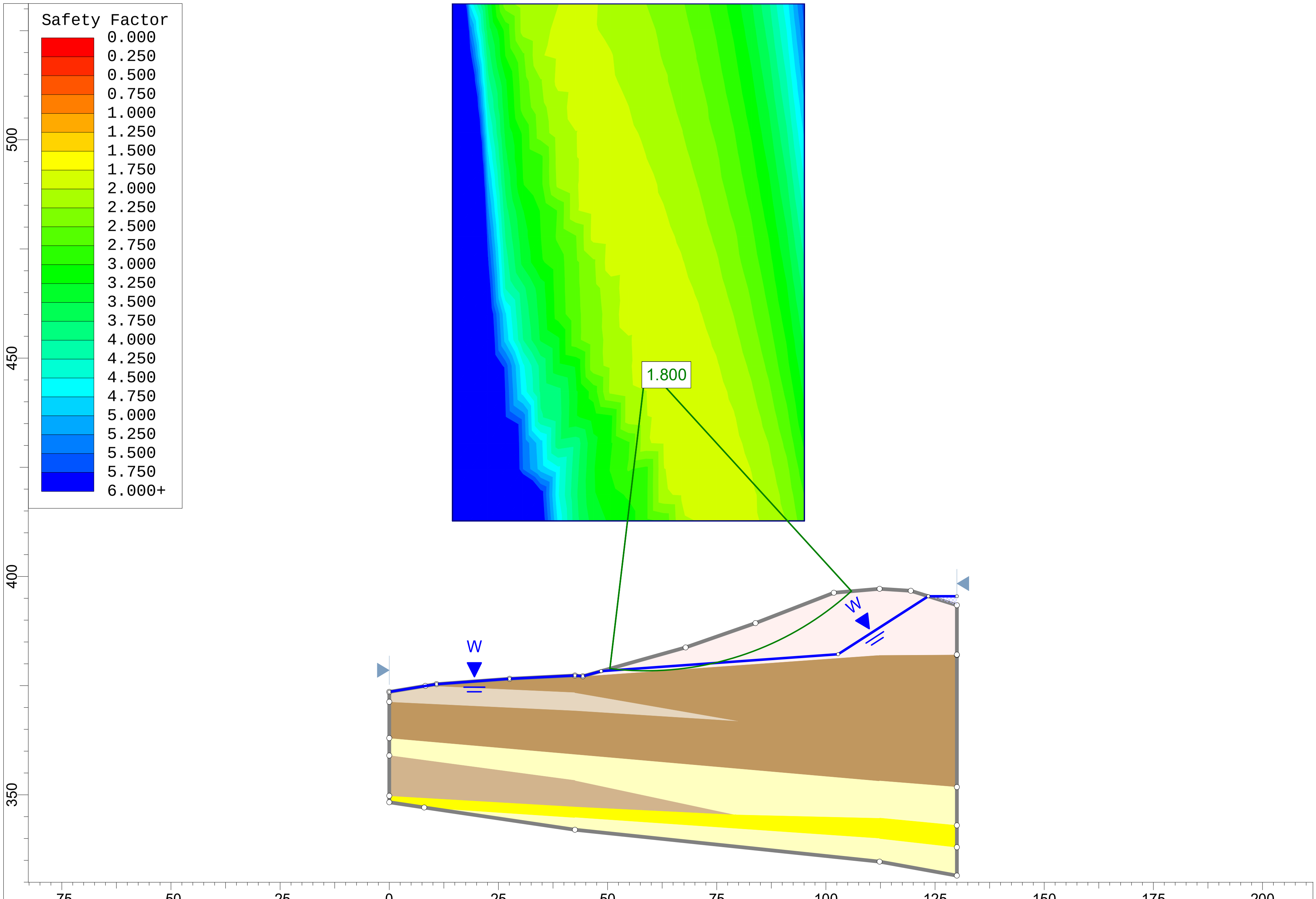
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date 9/5/2016, 3:56:57 PM | | File Name | GR-2 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |

| | |
|---|---|
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |

| | |
|---|---|
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

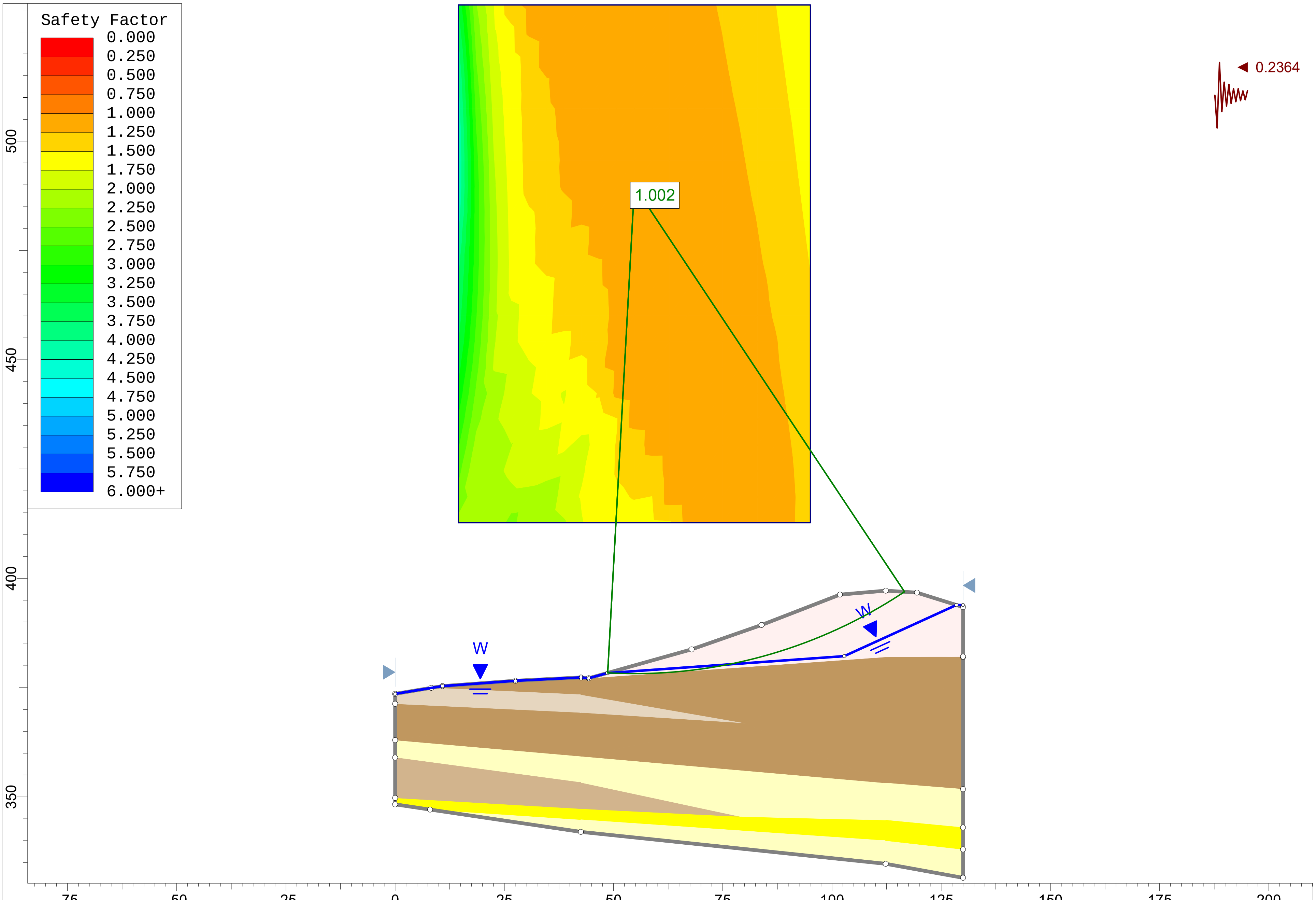
## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |

| | | | |
|---|---|---|---|
| SLIDE 6.039 | Project: BREC Green Station CCR Surface Impoundment | | |
| | Analysis Description: Cross Section GR-2 Seismic Loading Condition | | |
| | Drawn By: | Scale: | Company: Associated Engineers, Inc. |
| | Date: 9/5/2016, 3:56:57 PM | | File Name: GR-2 Seis 2.slim |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Seismic Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | | File Name GR-2 Seis 2.slim |

SLIDEINTERPRET 6.039

# *Slide Analysis Information*

# *BREC Green Station CCR Surface Impoundment*

## *Project Summary*

File Name: GR-2 Liq
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## *General Settings*

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## *Analysis Options*

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## *Groundwater Analysis*

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 0 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

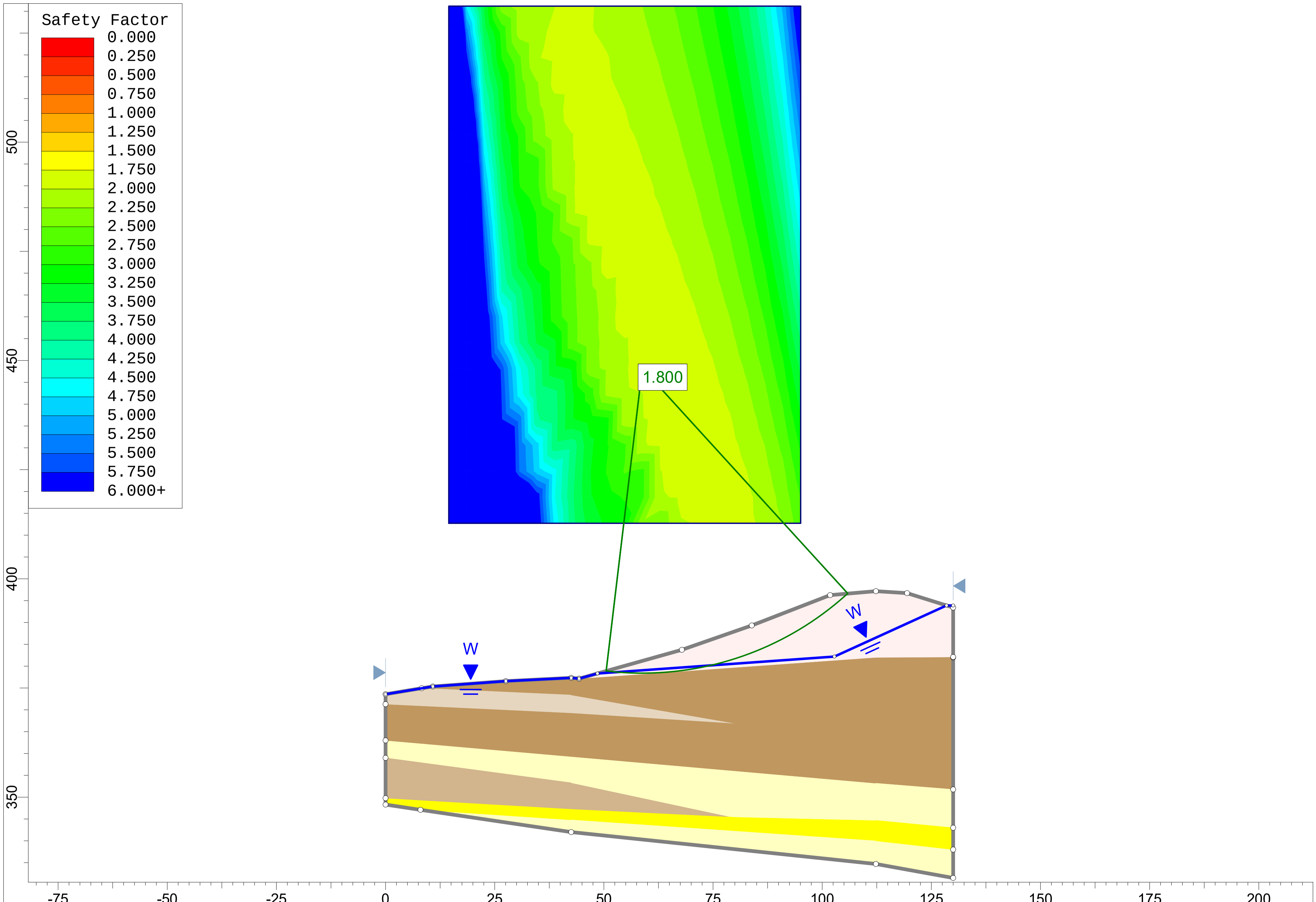
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Liquefaction Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | | File Name GR-2 Liq.slim |

SLIDEINTERPRET 6.039

Big Rivers
ELECTRIC CORPORATION
Your Touchstone Energy® Cooperative

# Reid/HMPL Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

**Project ID: 160027A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Reid/HMPL Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0855 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
>
> 3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

**From: VI. Development of the Final Rule - Technical Requirements**

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

The Calculated Liquefaction Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

## Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 25.45 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The original terrain on which the pond was constructed generally sloped toward the west. 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.

The embankment reaches its greatest relief of approximately 42 feet on the west side. The Burns & McDonnell Engineering Co. October 8, 1971 design drawings show the inboard slope and central core portion of the dike to be constructed of compacted soil fill and the outboard slope to be consisted of sand fill. A sand blanket drain was designed for the outboard third of the base of the dike for the majority of the length and the plans show a crushed limestone drainage layer with a minimum thickness of 18 inches topped with a minimum six inches thick sand layer which extends across the entire width of the dike cross section in the southwest corner. The plans also show a cut-off trench in the original ground below dike crest and extending for the entire length of the dike.

Depth of impounded water and CCR is 16 feet and 39 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 426 feet and 440 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 85,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 767,000 cubic yards (approximate water volume is 85,000 cubic yards and approximate CCR volume is 682,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.
The impoundment discharge consists of a rectangular concrete drop structure with a variable

height steel debris skimmer. The pool elevation can be controlled by adding or removing stop logs. The discharge structure connects to a 24-inch diameter smooth walled metal pipe underground conveyance.

## **Calculated Safety Factors**

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Reid/HMPL CCR impoundment are attached to this report.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 2.053

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 2.052

3. The calculated seismic factor of safety equals: 1.075

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.585

## **Sources of Information**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Reid/HMPL CCR Impoundment Initial Safety Factor Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

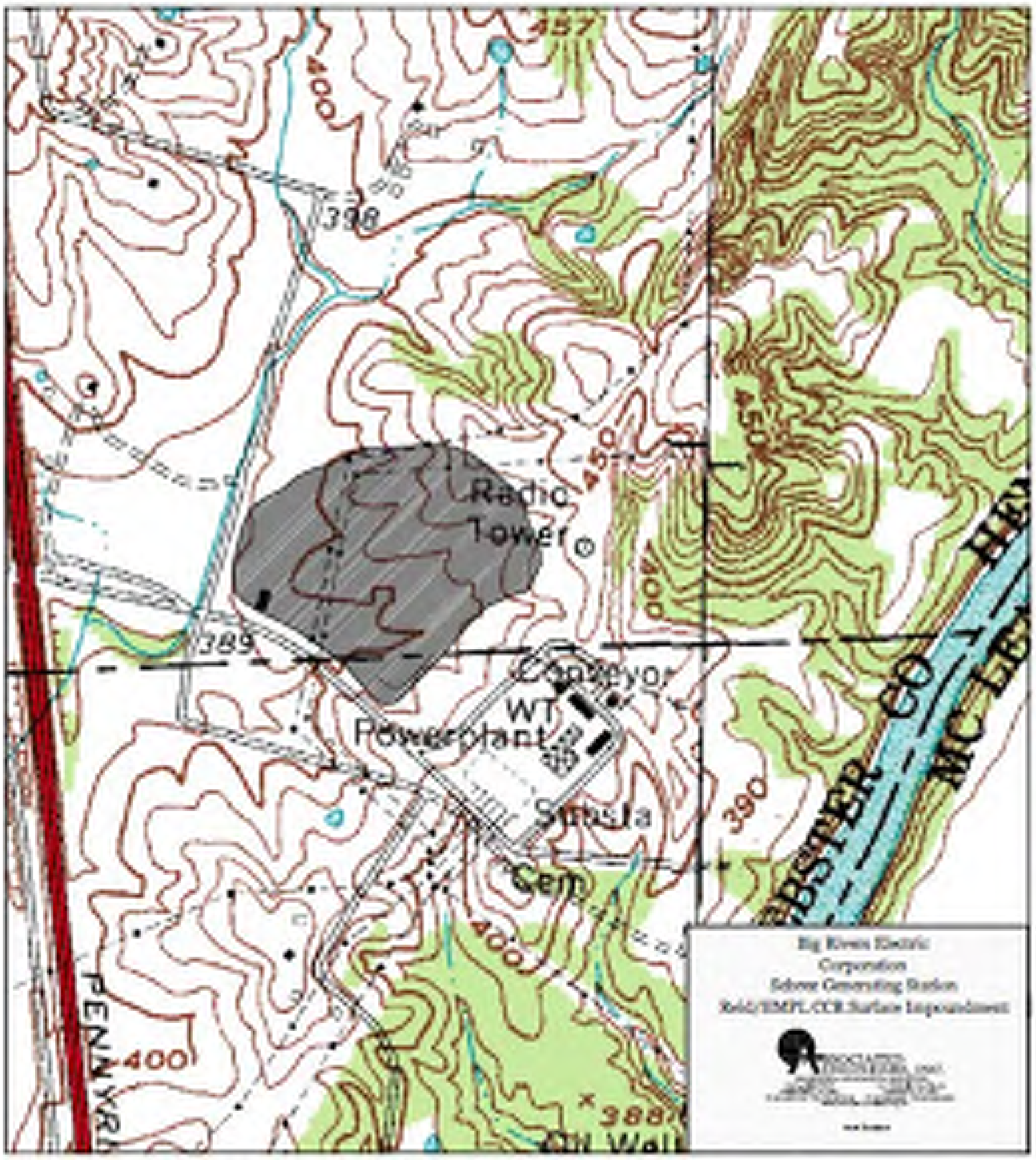
David A. Lamb

David A. Lamb P.E.
State of Kentucky License No. 17822

STATE OF KENTUCKY
DAVID A.
LAMB
17822
LICENSED
PROFESSIONAL ENGINEER

Date: 10/11/16


Attachment A. Aerial Photo of the Reid/HMPL CCR Surface Impoundment




Attachment B.  Topographic Map showing the Reid/HMPL CCR Surface Impoundment

# Slide Analysis Information

# Big Rivers Electric Corporation

## Project Summary

File Name: RH-1
Last saved with Slide version: 6.039
Project Title: Big Rivers Electric Corporation
Analysis: Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

### Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

### Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

### Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

### Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

### Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

### Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

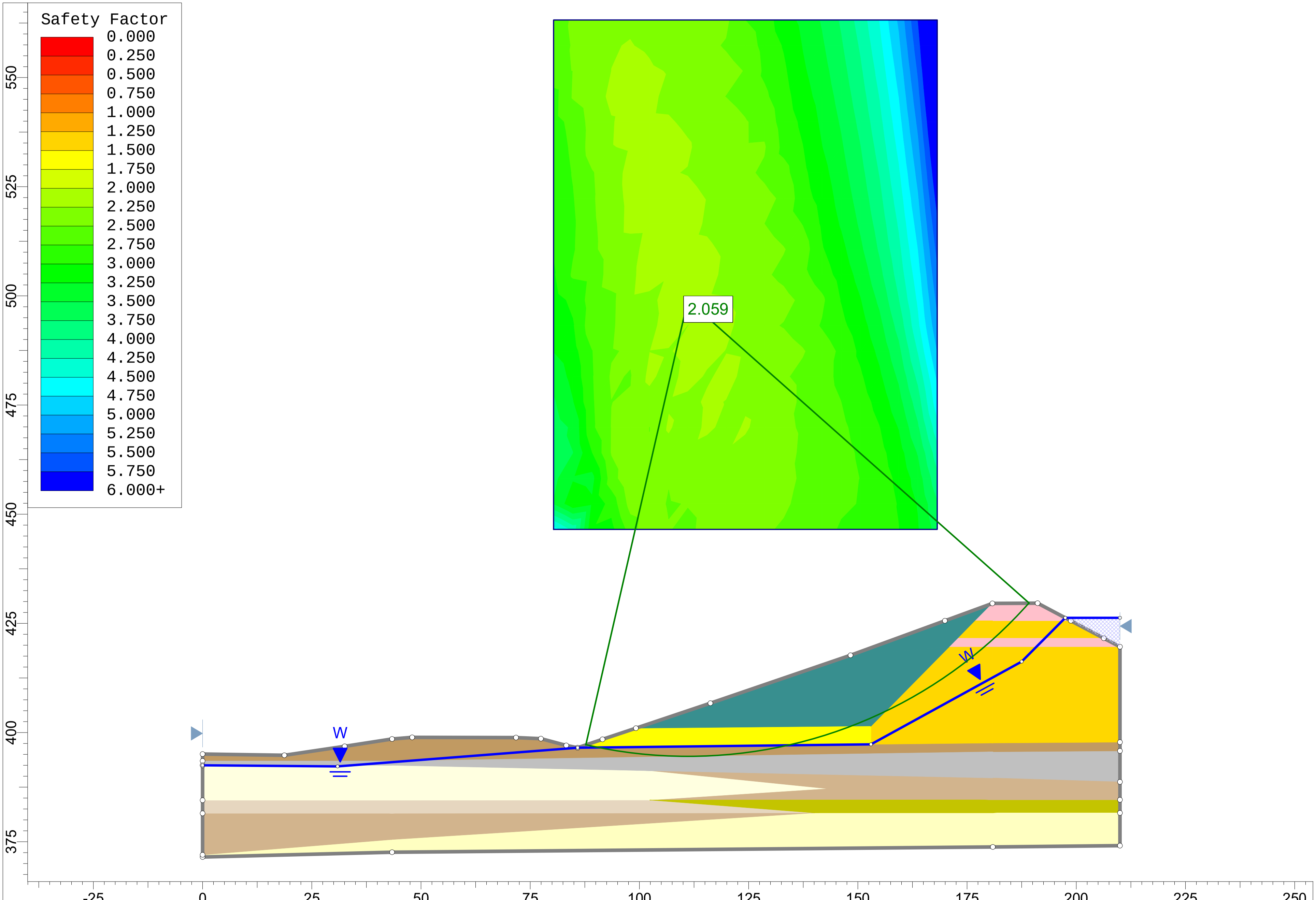
## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |

| | | | | |
|---|---|---|---|---|
| SLIDE 6.039 | *Project* Big Rivers Electric Corporation | | | |
| | *Analysis Description* Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition | | | |
| | *Drawn By* | *Scale* | *Company* Associated Engineers, Inc. | |
| | *Date* 9/5/2016, 2:31:54 PM | | *File Name* RH-1.slim | |




| | | | |
|---|---|---|---|
| *Project* | Big Rivers Electric Corporation | | |
| *Analysis Description* | Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition | | |
| *Drawn By* | *Scale* 1:360 | *Company* | Associated Engineers, Inc. |
| *Date* 9/5/2016, 2:31:54 PM | | *File Name* | RH-1.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 194.956 | 427.61 |
| 210 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

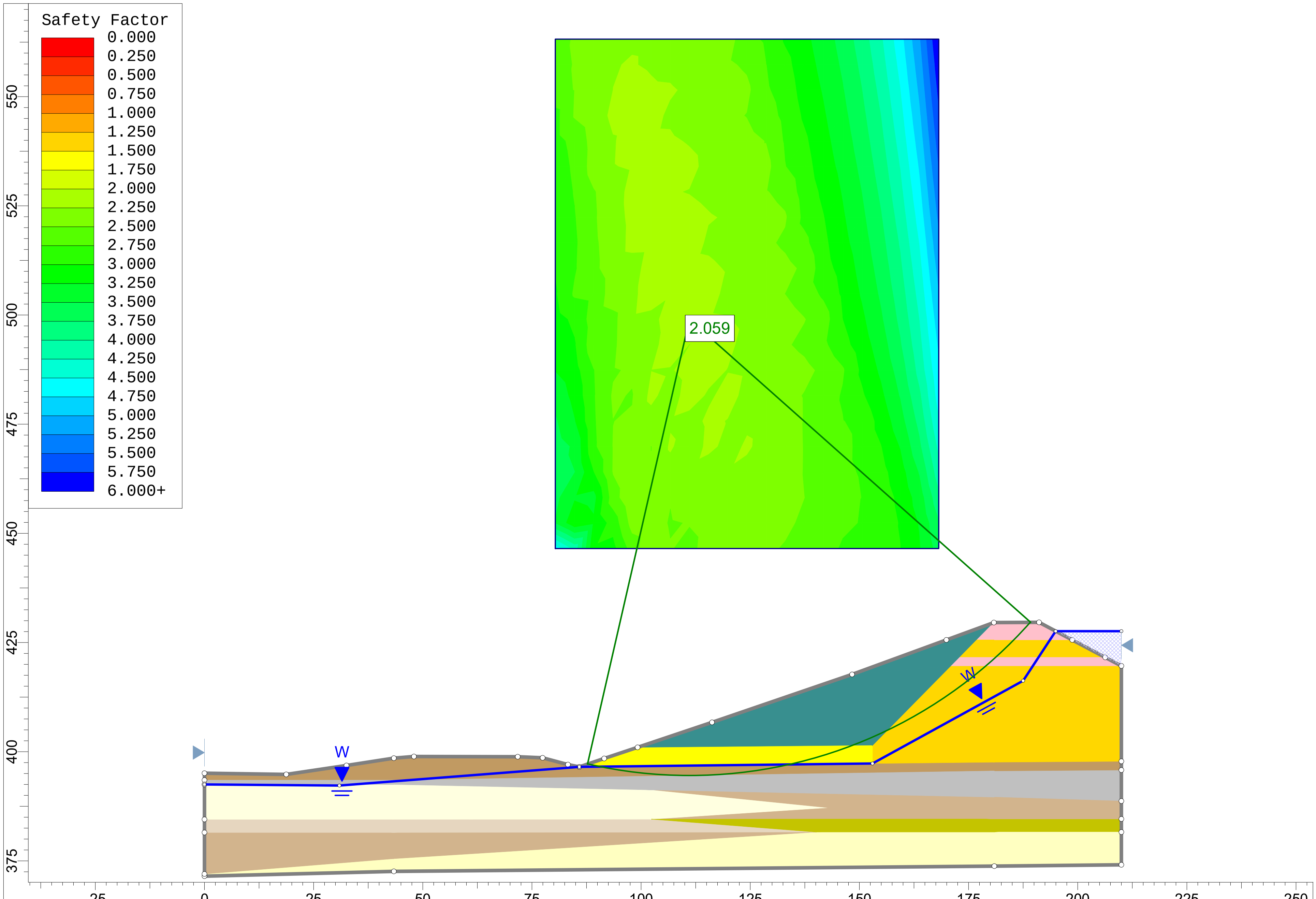
| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-1 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date 9/5/2016, 2:31:54 PM | | File Name | RH-1 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information
# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

## Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |

| | |
|---|---|
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
| --- | --- |
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

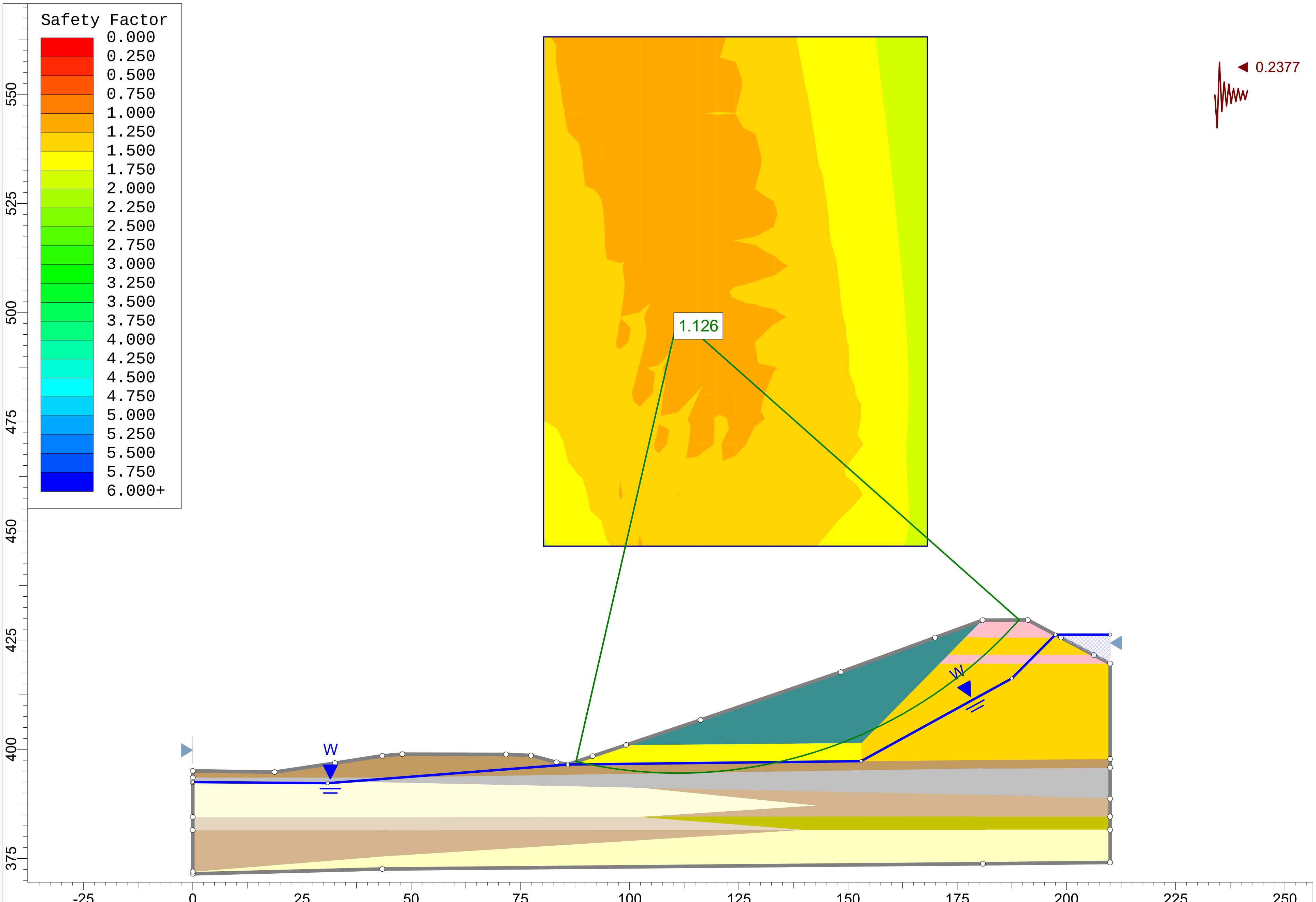
| X | Y |
| --- | --- |
| 102.292 | 384.543 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
| --- | --- |
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
| --- | --- |
| 176.879 | 425.6 |
| 180.9 | 425.6 |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | Project: BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | Analysis Description: Cross Section RH-1 Seismic Loading Condition | | |
| | Drawn By: | Scale: 1:360 | Company: Associated Engineers, Inc. |
| | Date: 9/5/2016, 2:31:54 PM | | File Name: RH-1 Seis.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Seis Liq
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 0 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 0 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

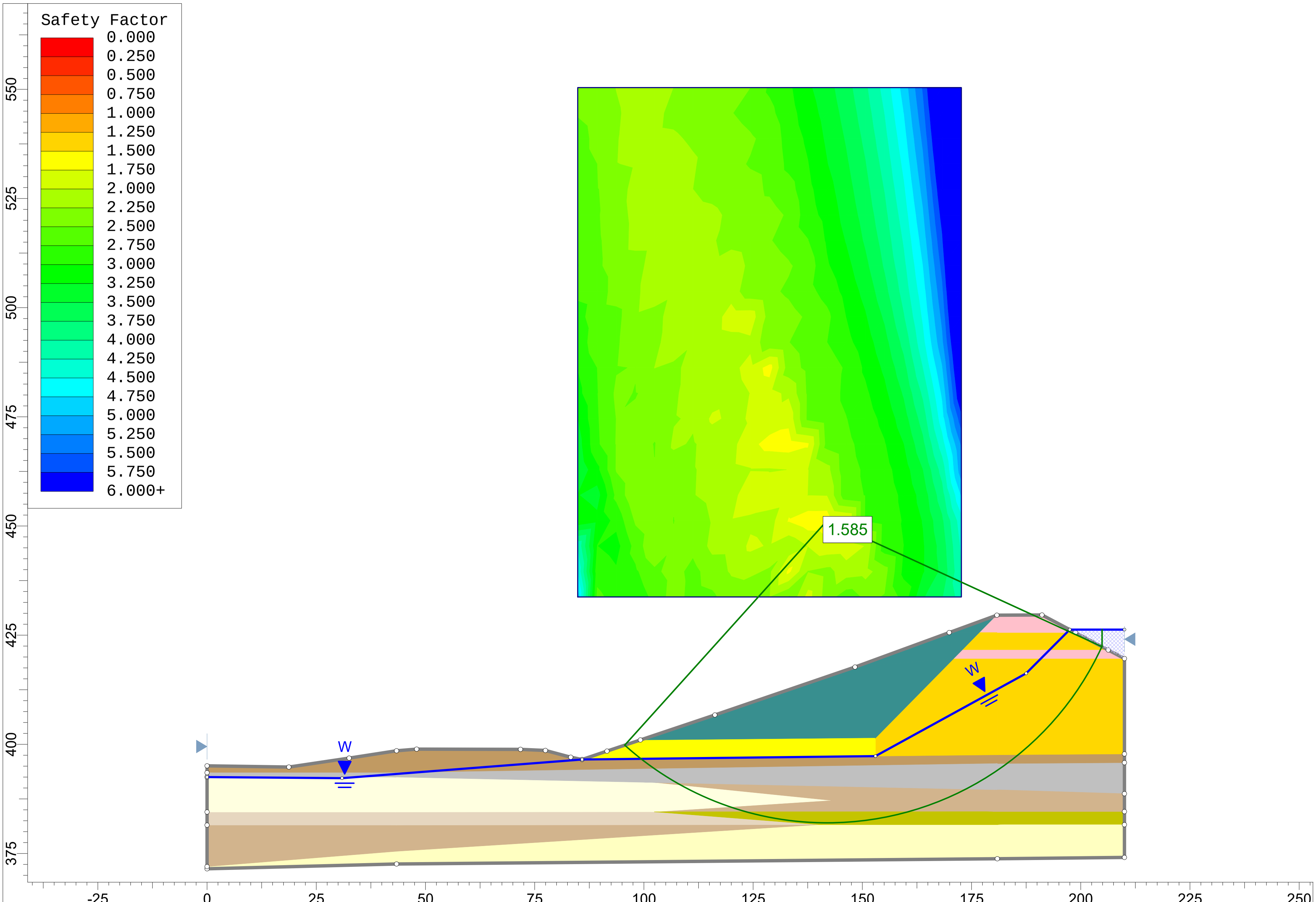
## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |

| | | | |
|---|---|---|---|
| SLIDE 6.039 | *Project* BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section RH-1 Liquefaction Condition | | |
| | *Drawn By* | *Scale* | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 2:31:54 PM | | *File Name* RH-1 Seis Liq.slim |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | *Project* BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section RH-1 Liquefaction Condition | | |
| | *Drawn By* | *Scale* 1:360 | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 2:31:54 PM | | *File Name* RH-1 Seis Liq.slim |

# Slide Analysis Information
# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 391.358 |

| | |
|---|---|
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 219.309 | 426.28 |
| 230 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |

| | |
|---|---|
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
|---|---|
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
|---|---|
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
|---|---|
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
|---|---|
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
|---|---|
| 181.19 | 407.768 |

| | |
|---|---|
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

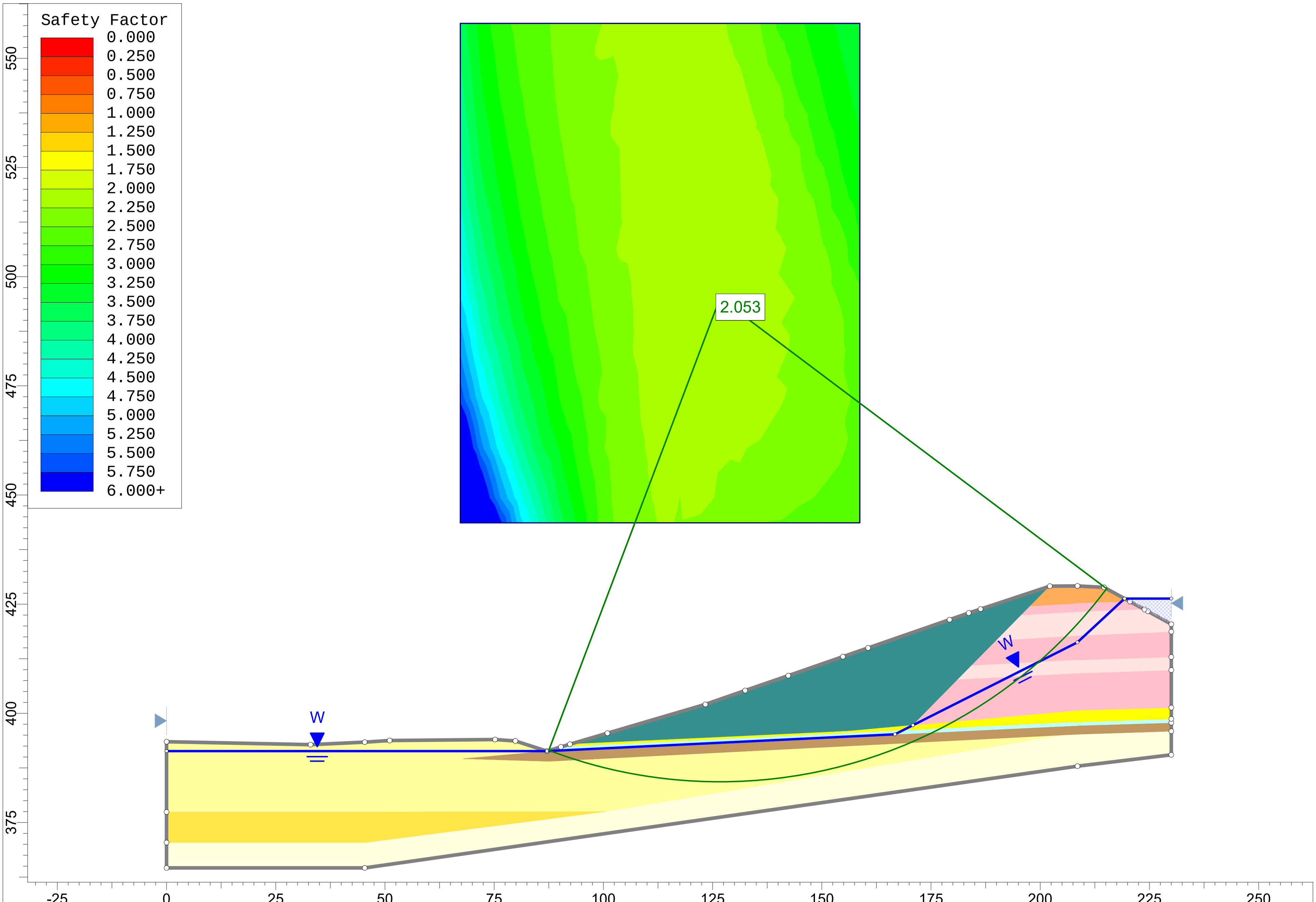
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-2 Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company: Associated Engineers, Inc. |
| Date | 9/5/2016, 3:14:15 PM | | File Name: RH-2.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 391.358 |

| | |
|---|---|
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 216.878 | 427.61 |
| 230 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |

| | |
|---|---|
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
|---|---|
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
|---|---|
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
|---|---|
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
|---|---|
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
|---|---|
| 181.19 | 407.768 |

| | |
|---|---|
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

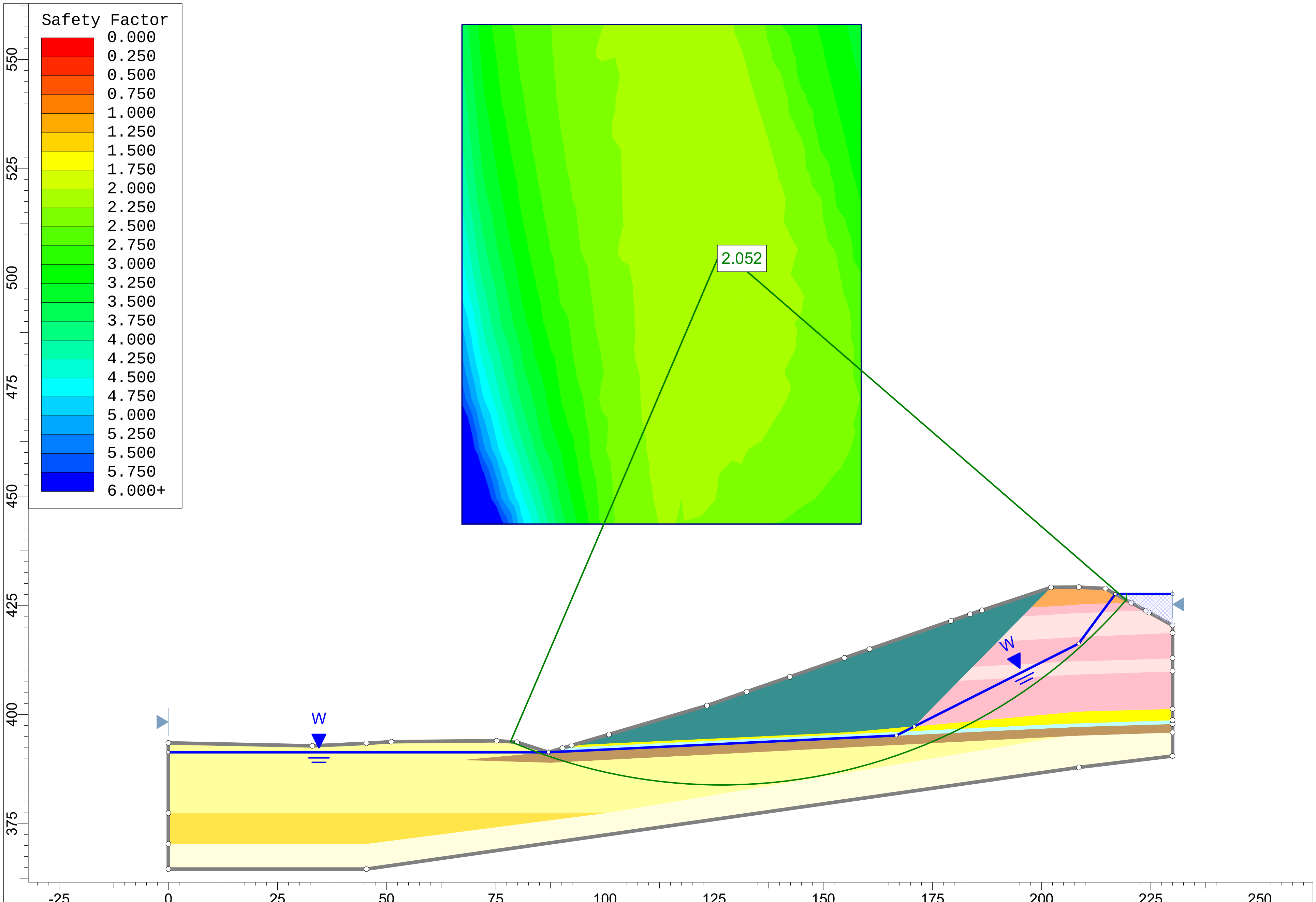
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




| | |
|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment |
| Analysis Description | Cross Section RH-2 Maximum Surcharge Pool Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:14:15 PM |
| File Name | RH-2 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

## Water Table

| X | Y |
|---|---|
| 0 | 391.358 |
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 219.309 | 426.28 |
| 230 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |

| | |
|---|---|
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
|---|---|
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
|---|---|
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
|---|---|
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
|---|---|
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
|---|---|
| 181.19 | 407.768 |
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

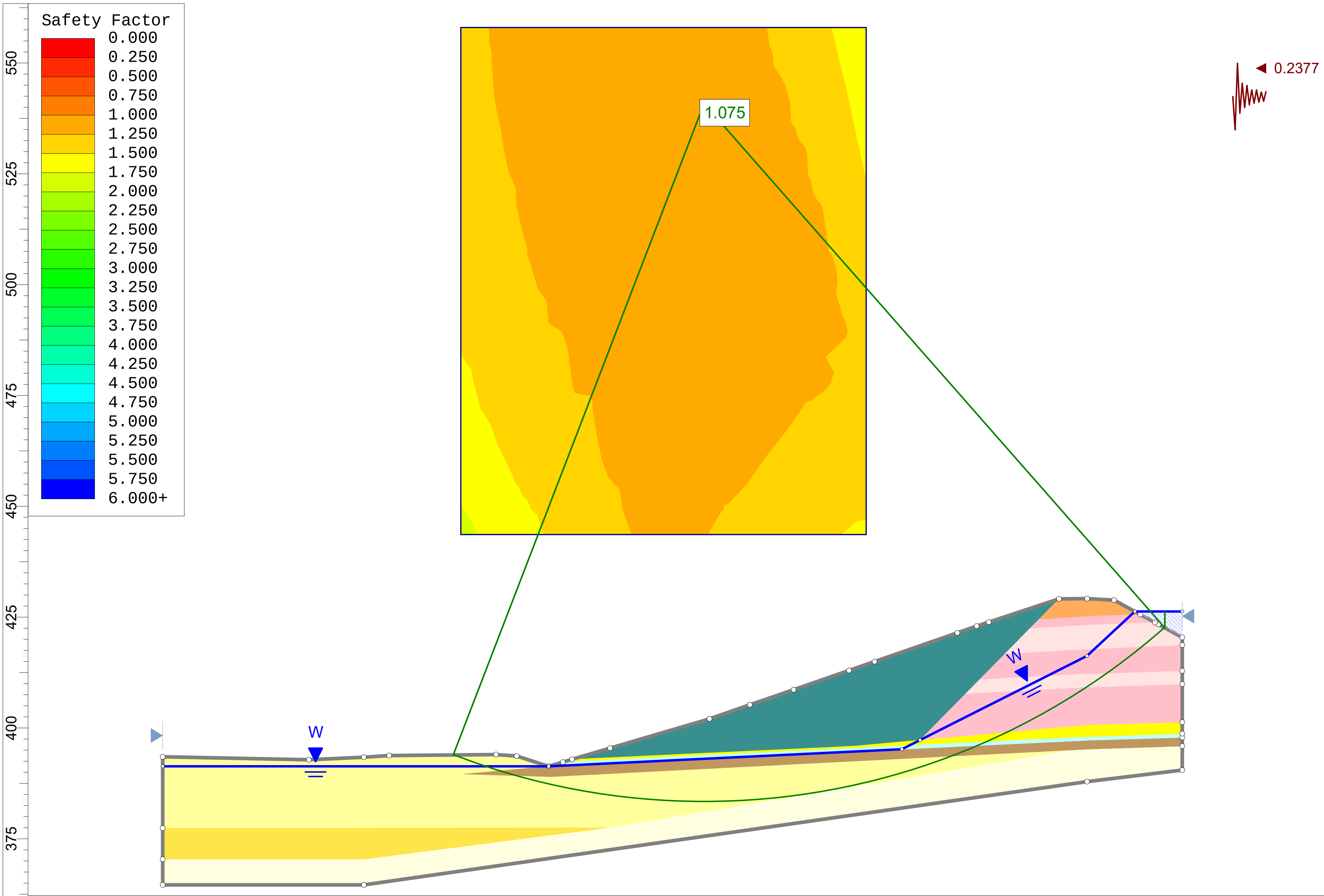
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




| | | | |
|---|---|---|---|
| *Project* | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| *Analysis Description* | Cross Section RH-2 Seismic Loading Condition | | |
| *Drawn By* | | *Scale* 1:360 | *Company* Associated Engineers, Inc. |
| *Date* | 9/5/2016, 3:14:15 PM | *File Name* | RH-2 Seis.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-3
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Maximum Storage Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 276.537 | 426.277 |
| 285 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |

| | |
|---|---|
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |

| | |
|---|---|
| 285 | 393.6 |

## Material Boundary

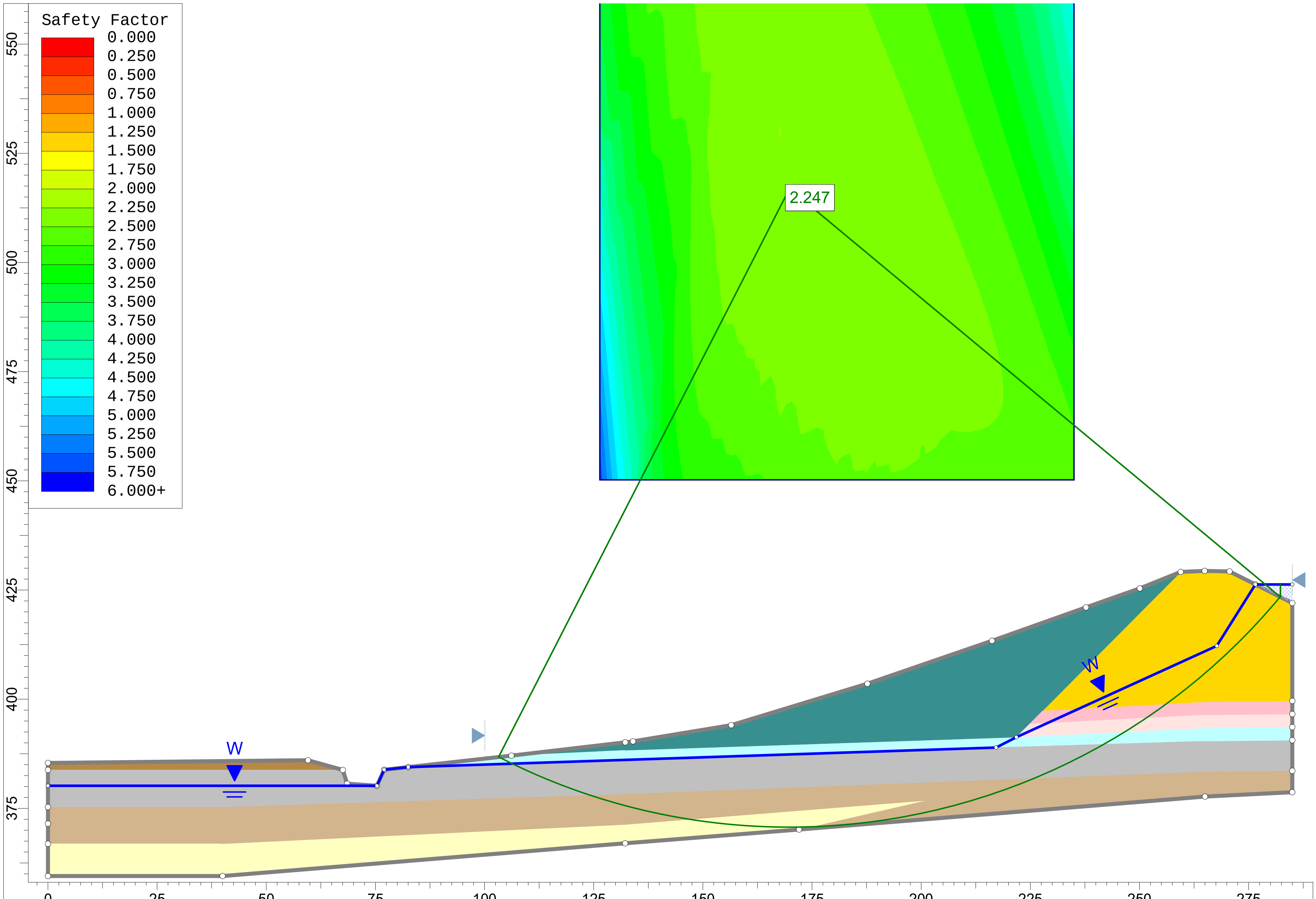
| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

## Material Boundary

| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |




SLIDEINTERPRET 6.039

| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-3 Maximum Storage Pool Loading Conditon | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 8/29/2016, 2:56:23 PM | File Name | RH-3.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impooundment

## Project Summary

File Name: RH-3 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impooundment
Analysis: Cross Section RH-3 Maximum Surcharge Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 273.872 | 427.613 |
| 285 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |

| | |
|---|---|
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |

| | |
|---|---|
| 285 | 393.6 |

## Material Boundary

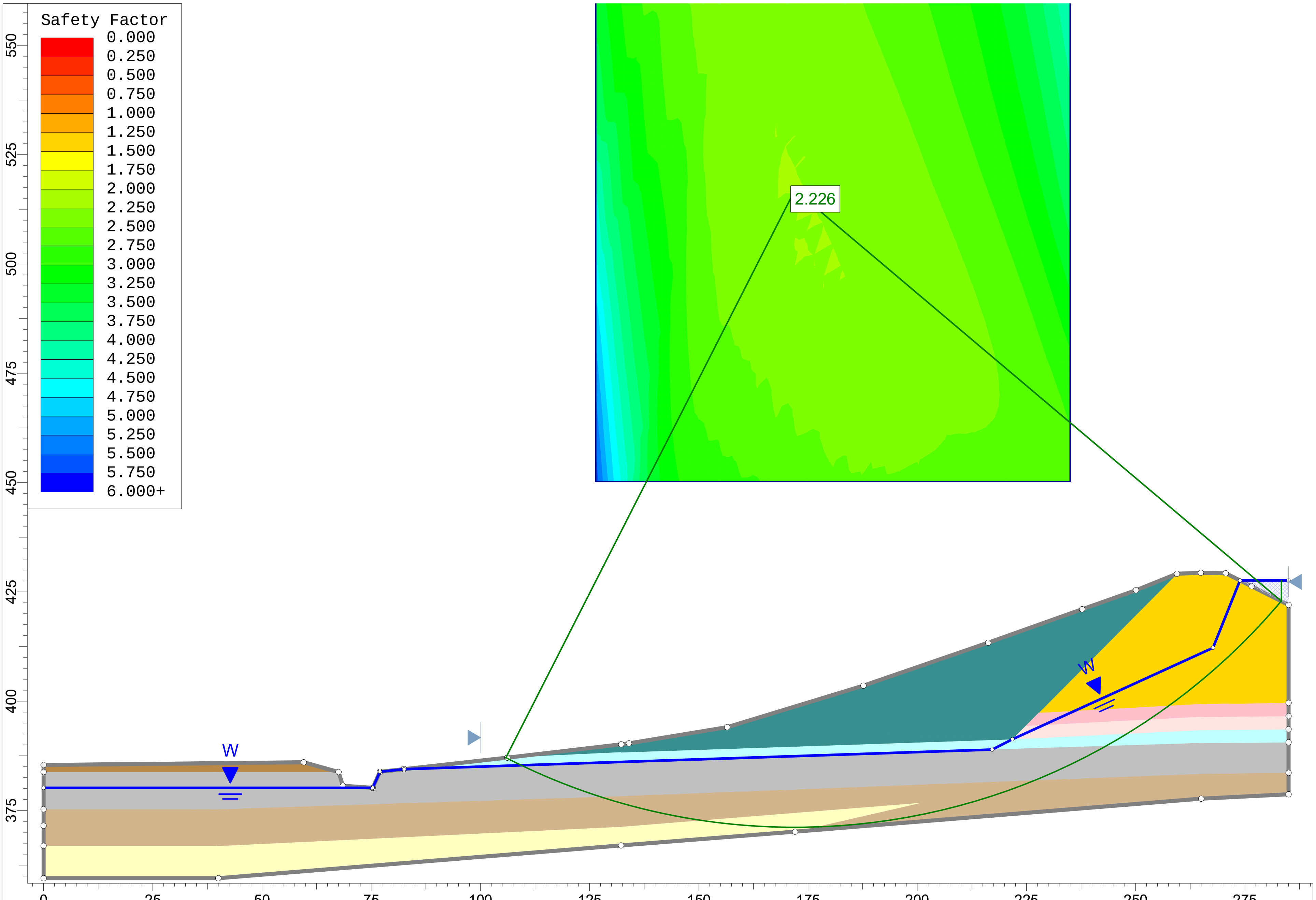
| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

## Material Boundary

| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | Project | BREC Reid/HMPL Station CCR Surface Impoundment | |
| | Analysis Description | Cross Section RH-3 Maximum Surcharge Pool Loading Conditon | |
| | Drawn By | Scale 1:360 | Company Associated Engineers, Inc. |
| | Date 8/29/2016, 2:56:23 PM | | File Name RH-3 Surcharge.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-3 Seis
Slide Modeler Version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Seismic Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular

Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## Global Minimums

### Method: bishop simplified

FS: 1.146920
Center: 169.832, 521.855
Radius: 150.630
Left Slip Surface Endpoint: 103.229, 386.750
Right Slip Surface Endpoint: 283.359, 422.856
Left Slope Intercept: 103.229 386.750
Right Slope Intercept: 283.359 426.279
Resisting Moment=4.1388e+007 lb-ft
Driving Moment=3.60862e+007 lb-ft

Total Slice Area=4300.6 ft2

## *Valid / Invalid Surfaces*

### Method: bishop simplified

Number of Valid Surfaces: 27798
Number of Invalid Surfaces: 813

#### Error Codes:

Error Code -103 reported for 812 surfaces
Error Code -108 reported for 1 surface

#### Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

## *Slice Data*

**Global Minimum Query (bishop simplified) - Safety Factor**: 1.14692

| Slice Number | Width [ft] | Weight [lbs] | Base Material | Base Cohesion [psf] | Base Friction Angle [degrees] | Shear Stress [psf] | Shear Strength [psf] | Base Normal Stress [psf] | Pore Pressure [psf] | Effective Normal Stress [psf] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.9517 | 339.413 | Granular Fill and Lean Clay | 0 | 31 | 80.4502 | 92.27 | 153.563 | 0 | 153.563 |
| 2 | 9.38923 | 5181.12 | Silty Clay (CL-ML) | 200 | 33.7 | 558.746 | 640.837 | 789.603 | 128.596 | 661.007 |
| 3 | 9.38923 | 10797.8 | Silty Clay (CL-ML) | 200 | 33.7 | 784.082 | 899.279 | 1423.39 | 374.861 | 1048.53 |
| 4 | 8.05892 | 13218.6 | Lean Clay | 72 | 30.4 | 715.465 | 820.581 | 1841.85 | 565.927 | 1275.92 |
| 5 | 8.05892 | 16561.5 | Lean Clay | 72 | 30.4 | 847.784 | 972.34 | 2244.15 | 709.561 | 1534.59 |
| 6 | 8.05892 | 19639.6 | Lean Clay | 72 | 30.4 | 970.425 | 1113 | 2598.53 | 824.191 | 1774.34 |
| 7 | 7.11739 | 19518.9 | Sandy Lean Clay | 120 | 32.3 | 1191.41 | 1366.45 | 2878.89 | 907.191 | 1971.7 |
| 8 | 7.11739 | 21628 | Sandy Lean Clay | 120 | 32.3 | 1296.89 | 1487.43 | 3125.23 | 962.17 | 2163.06 |
| 9 | 7.11739 | 23899.4 | Sandy Lean Clay | 120 | 32.3 | 1421.59 | 1630.45 | 3385.29 | 995.992 | 2389.3 |
| 10 | 7.11739 | 25852.9 | Sandy Lean Clay | 120 | 32.3 | 1527.15 | 1751.52 | 3589.6 | 1008.79 | 2580.81 |
| 11 | 7.97951 | 30912.3 | Lean Clay | 72 | 30.4 | 1474.5 | 1691.13 | 3758.42 | 998.688 | 2759.74 |
| 12 | 7.97951 | 32613.8 | Lean Clay | 72 | 30.4 | 1555.8 | 1784.38 | 3881.46 | 962.77 | 2918.69 |
| 13 | 7.97951 | 34074 | Lean Clay | 72 | 30.4 | 1630.67 | 1870.25 | 3964.78 | 899.728 | 3065.05 |
| 14 | 7.97951 | 35060.3 | Lean Clay | 72 | 30.4 | 1686.13 | 1933.86 | 3982.32 | 808.85 | 3173.47 |
| 15 | 7.97951 | 35547.6 | Lean Clay | 72 | 30.4 | 1722.09 | 1975.1 | 3932.9 | 689.137 | 3243.76 |
| 16 | 7.97951 | 35611.6 | Lean Clay | 72 | 30.4 | 1688.19 | 1936.22 | 3846.3 | 668.812 | 3177.49 |
| 17 | 8.30823 | 36828.4 | Silty Clay (CL-ML) | 200 | 33.7 | 1874.3 | 2149.67 | 3621.62 | 698.224 | 2923.4 |
| 18 | 8.30823 | 36298.1 | Silty Clay (CL-ML) | 200 | 33.7 | 1786.34 | 2048.79 | 3462.85 | 690.709 | 2772.14 |
| 19 | 4.95864 | 21118.6 | Granular Fill and Lean Clay | 0 | 31 | 1451.21 | 1664.42 | 3429.39 | 659.333 | 2770.06 |
| 20 | 5.12784 | 21134.1 | Lean Clay with Sand (CL) (Dam) | 260 | 30.6 | 1539.33 | 1765.49 | 3159.94 | 614.305 | 2545.64 |
| 21 | 4.73463 | 18862 | Lean Clay (CL) (Dam) | 220 | 30.4 | 1443.82 | 1655.95 | 3001.55 | 554.028 | 2447.52 |
| 22 | 6.60985 | 24515 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 1310.13 | 1502.61 | 2725.55 | 459.958 | 2265.59 |
| 23 | 6.60985 | 20127.3 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 1061.56 | 1217.53 | 2150.92 | 319.337 | 1831.59 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 6.60985 | 13526.4 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 565.291 | 648.343 | 1510.28 | 545.202 | 965.081 |
| 25 | 6.60985 | 5362.88 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 141.118 | 161.851 | 659.69 | 435.217 | 224.473 |

## *Interslice Data*

**Global Minimum Query (bishop simplified) - Safety Factor**: 1.14692

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 103.229 | 386.75 | 0 | 0 | 0 |
| 2 | 106.18 | 385.335 | 374.121 | 0 | 0 |
| 3 | 115.57 | 381.338 | 7543.64 | 0 | 0 |
| 4 | 124.959 | 378.064 | 16998.2 | 0 | 0 |
| 5 | 133.018 | 375.793 | 23804.5 | 0 | 0 |
| 6 | 141.077 | 373.995 | 30733.8 | 0 | 0 |
| 7 | 149.136 | 372.654 | 37371.2 | 0 | 0 |
| 8 | 156.253 | 371.839 | 43557.5 | 0 | 0 |
| 9 | 163.37 | 371.364 | 49129.3 | 0 | 0 |
| 10 | 170.488 | 371.227 | 54029.8 | 0 | 0 |
| 11 | 177.605 | 371.426 | 58037.4 | 0 | 0 |
| 12 | 185.585 | 372.051 | 60103.9 | 0 | 0 |
| 13 | 193.564 | 373.107 | 60668.5 | 0 | 0 |
| 14 | 201.544 | 374.601 | 59653.7 | 0 | 0 |
| 15 | 209.523 | 376.549 | 57017.3 | 0 | 0 |
| 16 | 217.503 | 378.968 | 52794.3 | 0 | 0 |
| 17 | 225.482 | 381.882 | 46588 | 0 | 0 |
| 18 | 233.79 | 385.478 | 40381 | 0 | 0 |
| 19 | 242.099 | 389.693 | 31998 | 0 | 0 |
| 20 | 247.057 | 392.528 | 24451.6 | 0 | 0 |
| 21 | 252.185 | 395.731 | 17198.2 | 0 | 0 |
| 22 | 256.92 | 398.953 | 9880.41 | 0 | 0 |
| 23 | 263.53 | 403.914 | -811.059 | 0 | 0 |
| 24 | 270.139 | 409.482 | -10555.3 | 0 | 0 |
| 25 | 276.749 | 415.751 | -19503.3 | 0 | 0 |
| 26 | 283.359 | 422.856 | 365.715 | 0 | 0 |

## *List Of Coordinates*

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 276.537 | 426.277 |

| | |
|---|---|
| 285 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |
| 285 | 393.6 |

## Material Boundary

| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

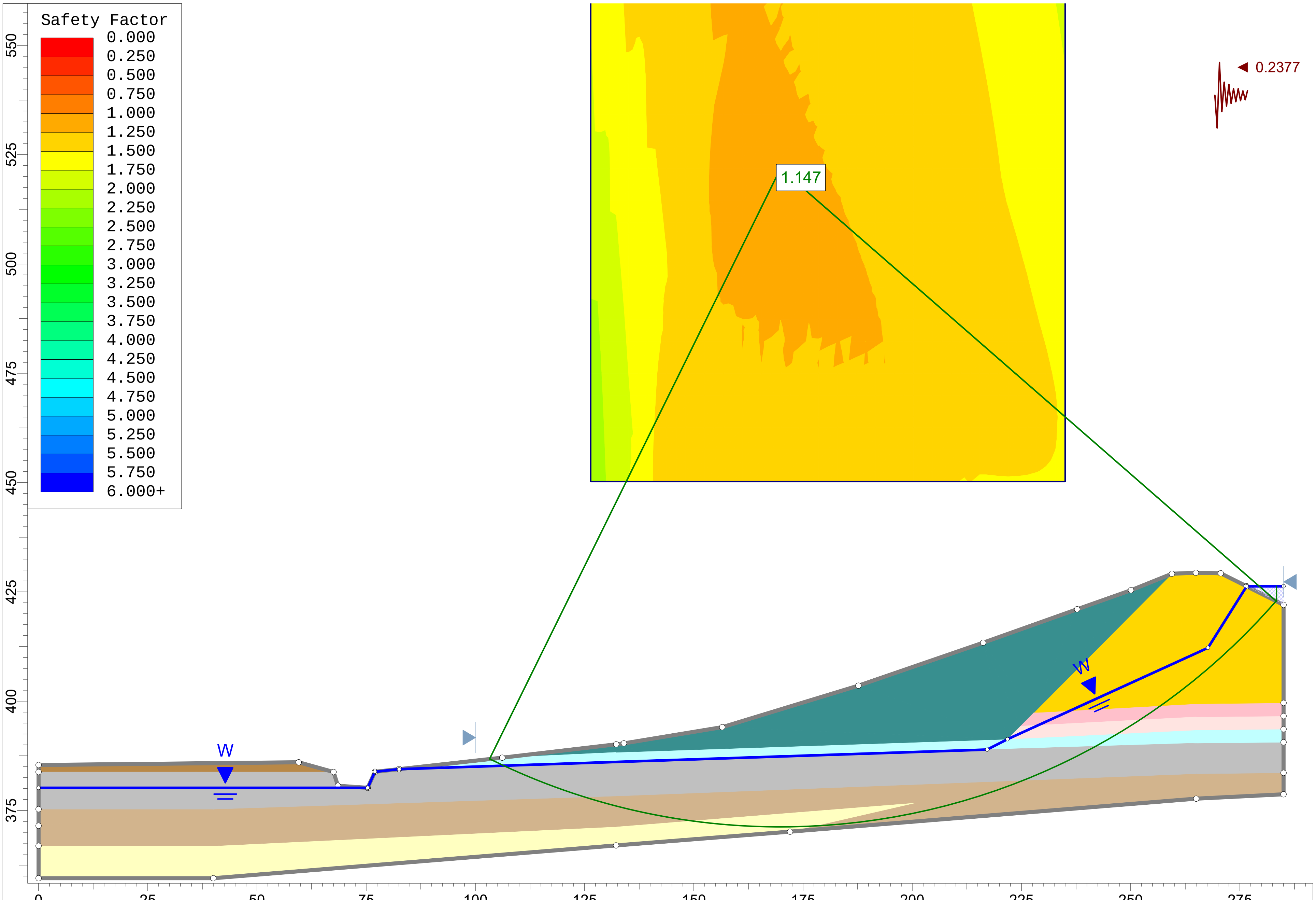
## Material Boundary

| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-3 Seismic Loading Conditon | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date | 8/29/2016, 2:56:23 PM | File Name | RH-3 Seis.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-4
Last saved with Slide version: 6.039
Project Title: BREC Reid HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Lean Clay (CL) | Silty Clay (CL-ML) | Lean Clay With Sand (CL) (Dam) | Lean Clay (CL) (Dam) | Silty Sand (SM) | Outslope Material (Dam) | Lean Clay (CL) (1) | Lean Clay (CL)/Clayey Sand (SC) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 128 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 200.877 | 426.28 |
| 215 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |
| 189.8 | 409.4 |

| | |
|---|---|
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
|---|---|
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

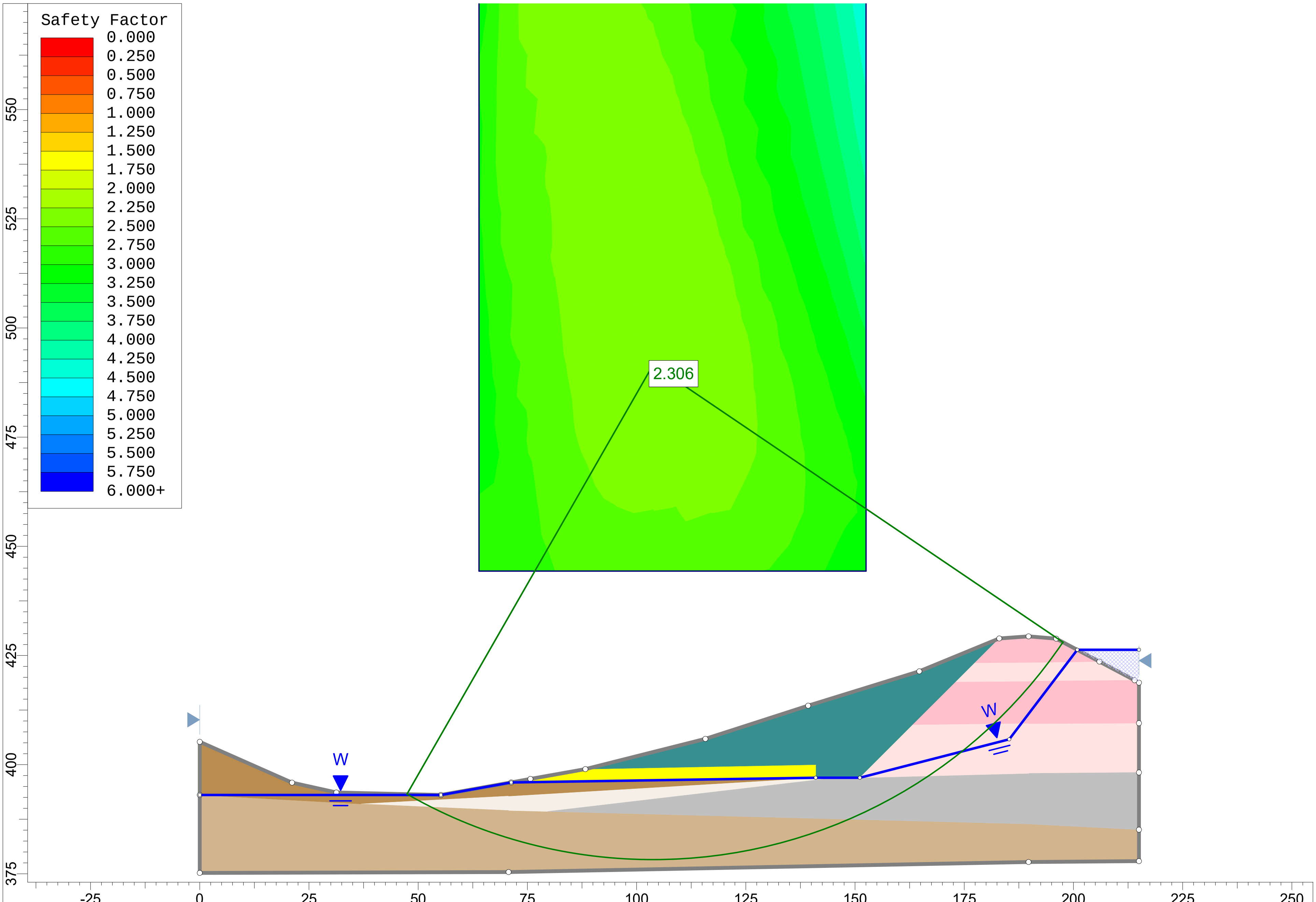
| X | Y |
|---|---|
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
|---|---|
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | |
|---|---|
| *Project* | BREC Reid HMPL Station CCR Surface Impoundment |
| *Analysis Description* | Cross Section RH-4 Maximum Storage Pool Loading Condition |
| *Drawn By* | *Scale* 1:360 |
| *Company* | Associated Engineers, Inc. |
| *Date* 9/4/2016, 12:09:41 PM | *File Name* RH-4.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-4 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Lean Clay (CL) | Silty Clay (CL-ML) | Lean Clay With Sand (CL) (Dam) | Lean Clay (CL) (Dam) | Silty Sand (SM) | Outslope Material (Dam) | Lean Clay (CL) (1) | Lean Clay (CL)/Clayey Sand (SC) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 128 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 198.372 | 427.61 |
| 215 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |
| 189.8 | 409.4 |

| | |
|---|---|
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
|---|---|
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

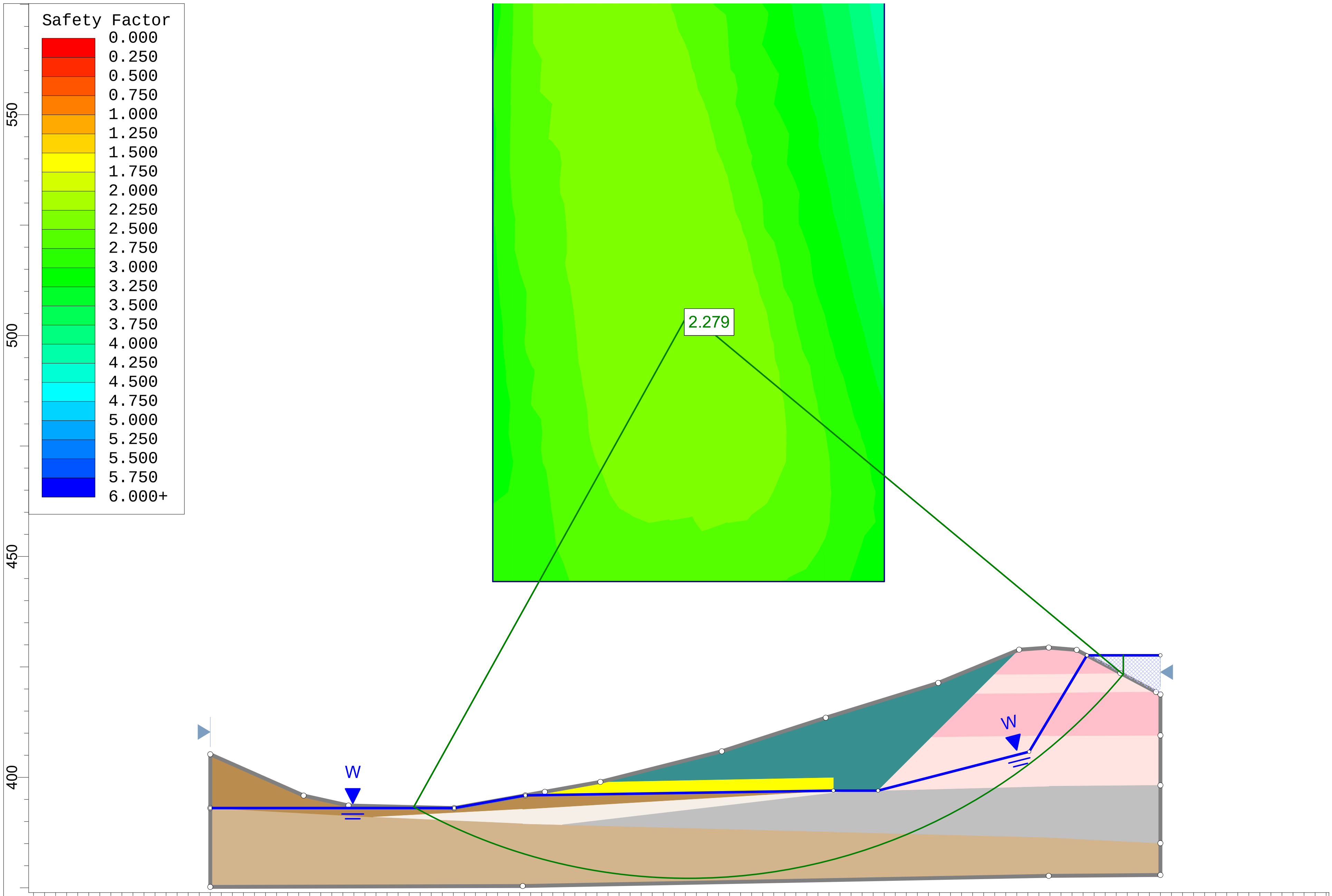
| X | Y |
|---|---|
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
|---|---|
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-4 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/4/2016, 12:09:41 PM | | File Name RH-4 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information
# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-4 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Lean clay | Silty clay | Lean Clay with sand (dike) | Lean clay (dike) | Silty sand (SM) | Sandy wedge | Lean clay OG | Lean clay with sand |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 130 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 200.877 | 426.28 |
| 215 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |

| | | | |
|---|---|---|---|
| | Project: BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | Analysis Description: Cross Section RH-4 Seismic Loading Condition | | |
| | Drawn By: | Scale: | Company: Associated Engineers, Inc. |
| SLIDE 6.039 | Date: 9/4/2016, 12:09:41 PM | | File Name: RH-4 Seis 2.slim |

| | |
|---|---|
| 189.8 | 409.4 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
|---|---|
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

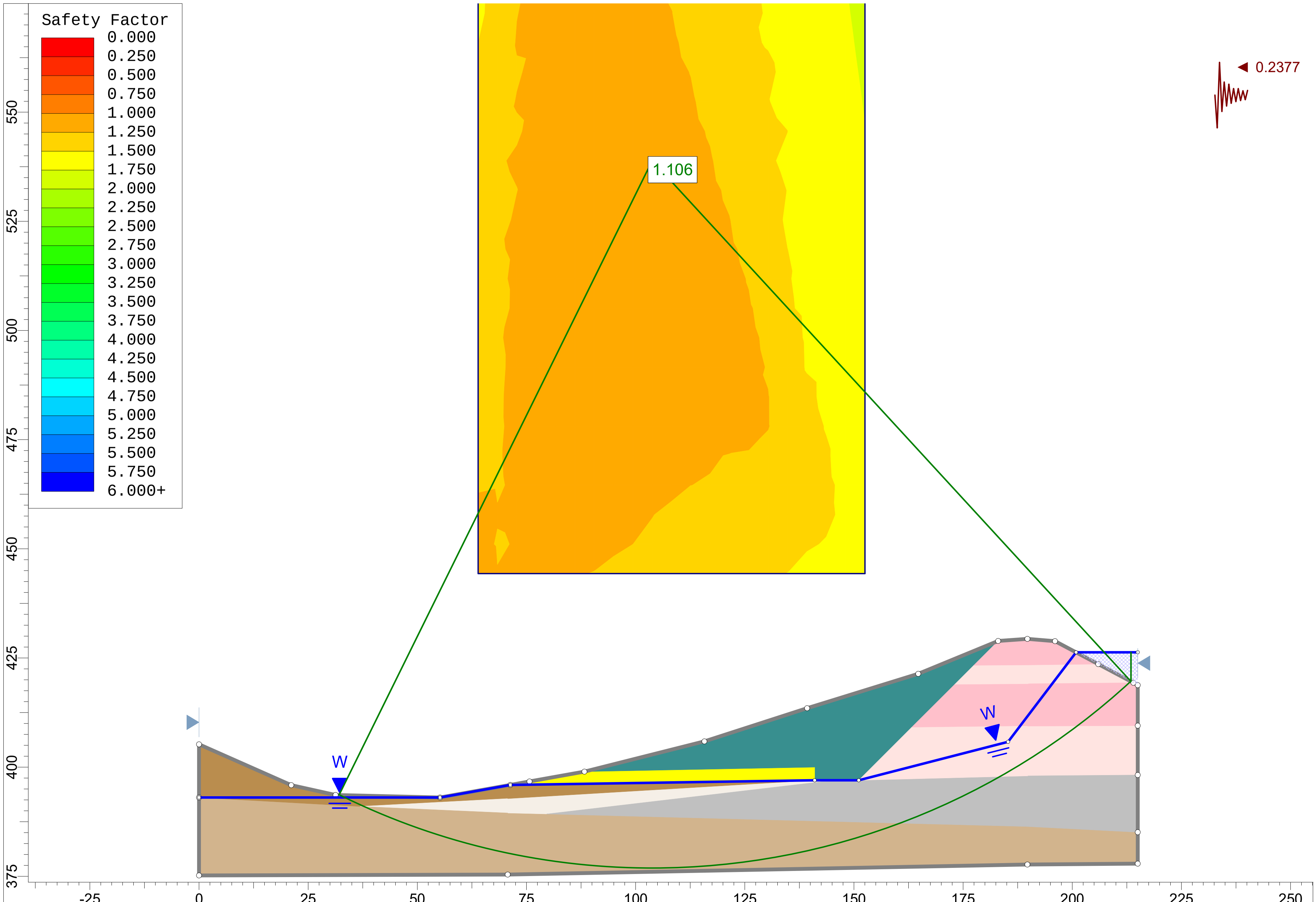
| X | Y |
|---|---|
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
|---|---|
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-4 Seismic Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date | 9/4/2016, 12:09:41 PM | File Name | RH-4 Seis 2.slim |

SLIDEINTERPRET 6.039

## ATTACHMENT 12 - SAFETY FACTOR ASSESSMENT (OCTOBER 2016)

Big Rivers
ELECTRIC CORPORATION
Your Touchstone Energy® Cooperative

# Green Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

**Project ID: 160028A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Green Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0980 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
>
> 3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

**From: VI. Development of the Final Rule - Technical Requirements**

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface

impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

<u>The Calculated Liquefaction Factor of Safety</u>

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

<u>Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment</u>

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

## <u>**Description of Impoundment**</u>

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit has been in place for 40 plus years. The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant 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. The toe of the outboard slope intersected a lower drainage area. 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.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 16 feet and 46 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 394 feet and 408 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 172,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 981,000 cubic yards (approximate water volume is 172,000 cubic yards and approximate CCR volume is 809,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of two corrugated steel pipes, each 30 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

**Calculated Safety Factors**

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Green CCR impoundment are attached to this report.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 1.800

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 1.800

3. The calculated seismic factor of safety equals: 1.002

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.800

**Sources of Information**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Green CCR Impoundment Initial Safety Factor Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.
State of Kentucky License No. 17822

Date: 10/11/16


Attachment A.  Aerial Photo of the Green CCR Surface Impoundment


Attachment B. Topographic Map showing the Green CCR Surface Impoundment

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |

| | |
|---|---|
| 170.48 | 366.698 |

## Material Boundary

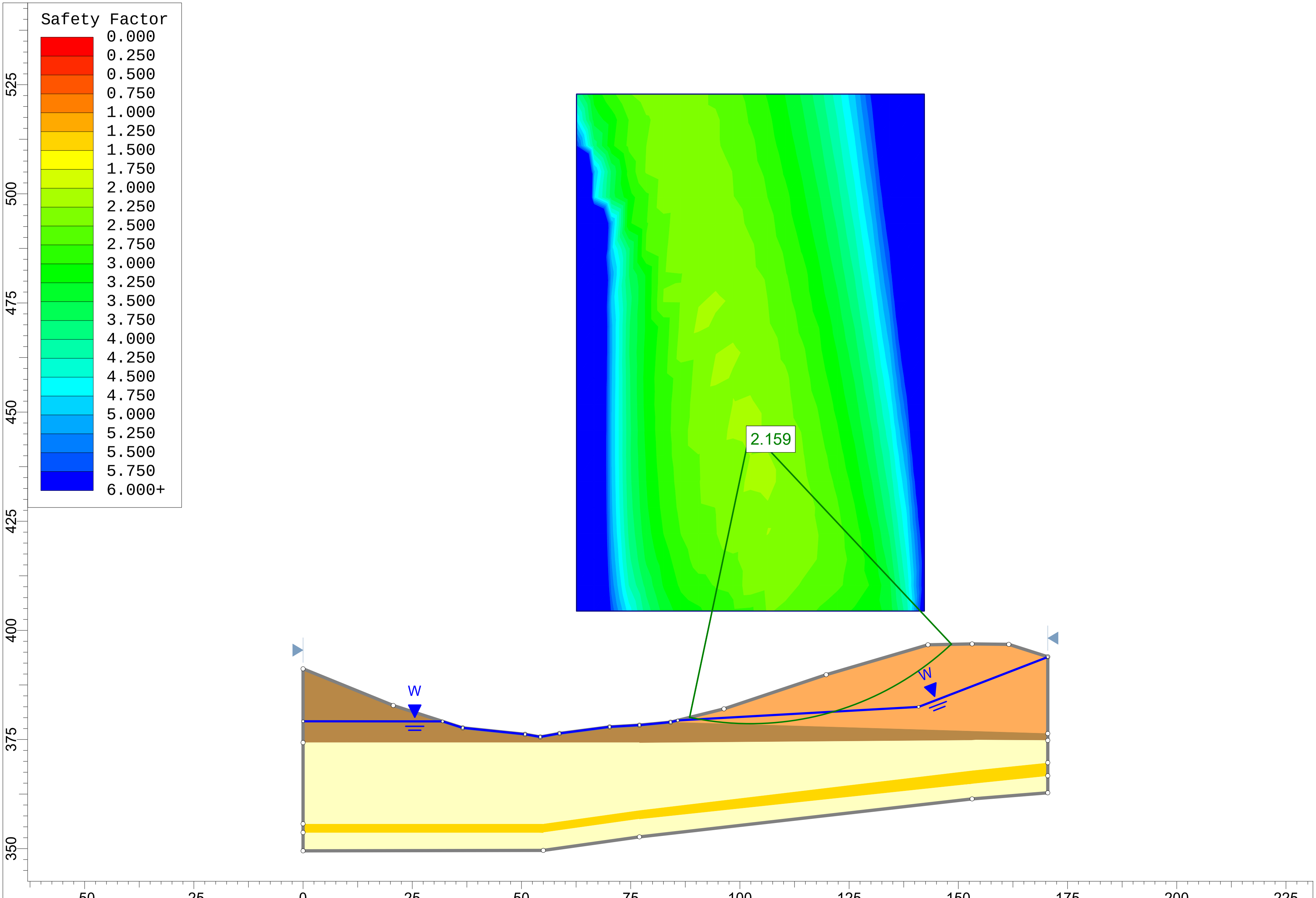
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc |
| Date | 9/5/2016, 3:43:18 PM | File Name | GR-1.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy lean clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 165.719 | 395.483 |
| 170.48 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |

| | |
|---|---|
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

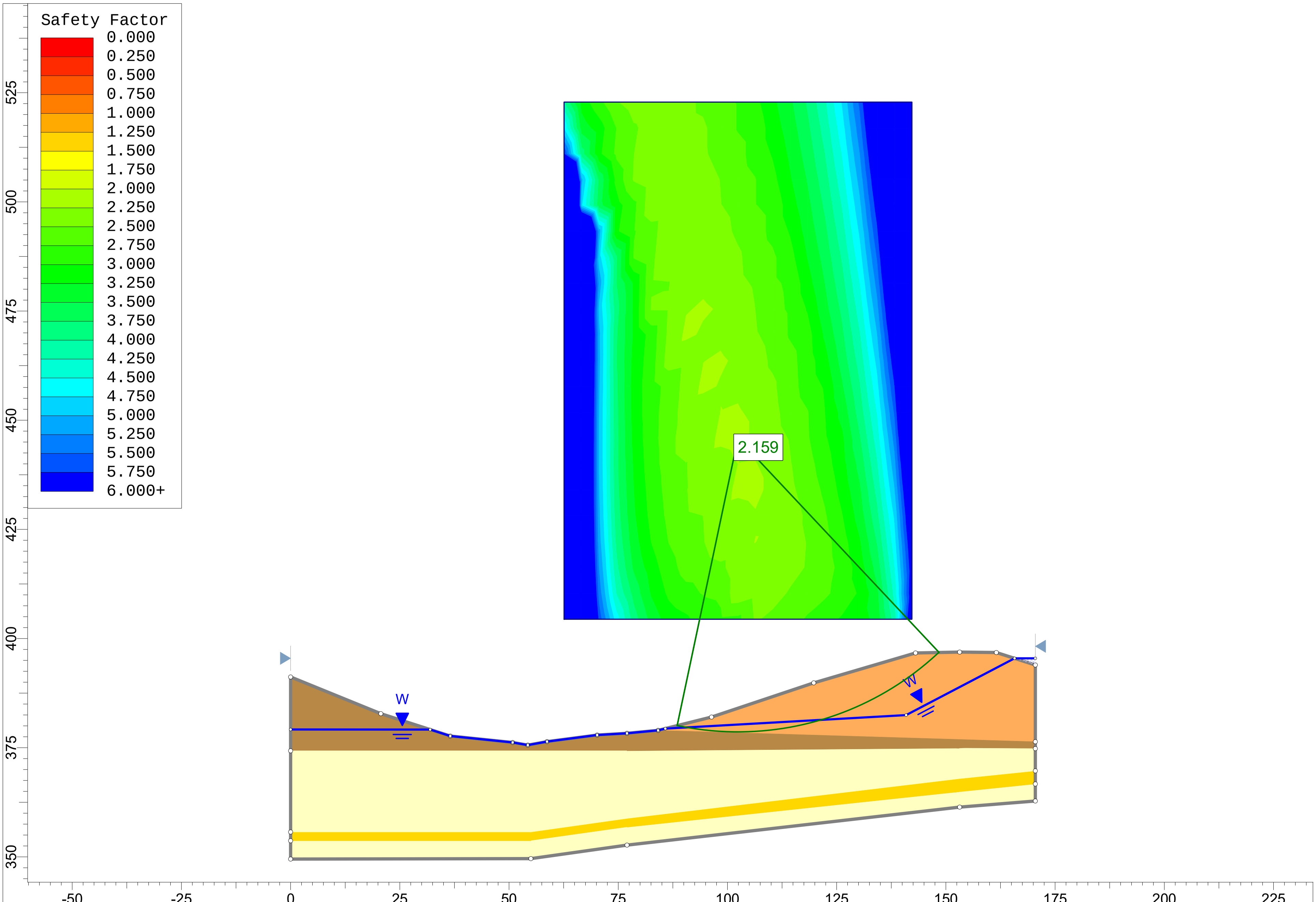
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc |
| Date 9/5/2016, 3:43:18 PM | | File Name | GR-1 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Seismic Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |

| | |
|---|---|
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

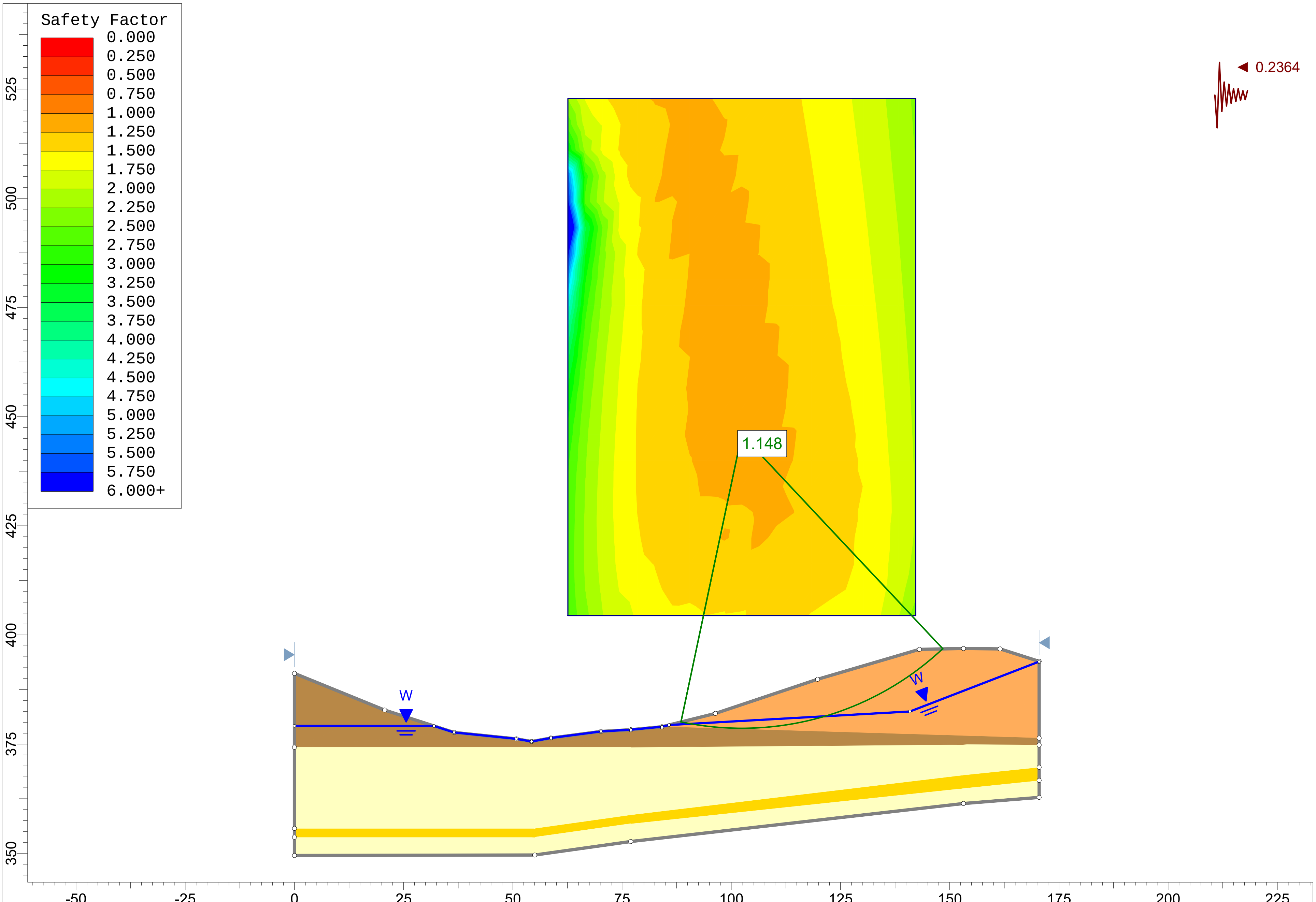
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | Project: BREC Green Station CCR Surface Impoundment | | |
| | Analysis Description: Cross Section GR-1 Seismic Loading Condition | | |
| | Drawn By: | Scale: 1:360 | Company: Associated Engineers, Inc |
| | Date: 9/5/2016, 3:43:18 PM | | File Name: GR-1 Seis.slim |

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale | Company: Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | File Name | GR-2.slim |

SLIDE 6.039

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

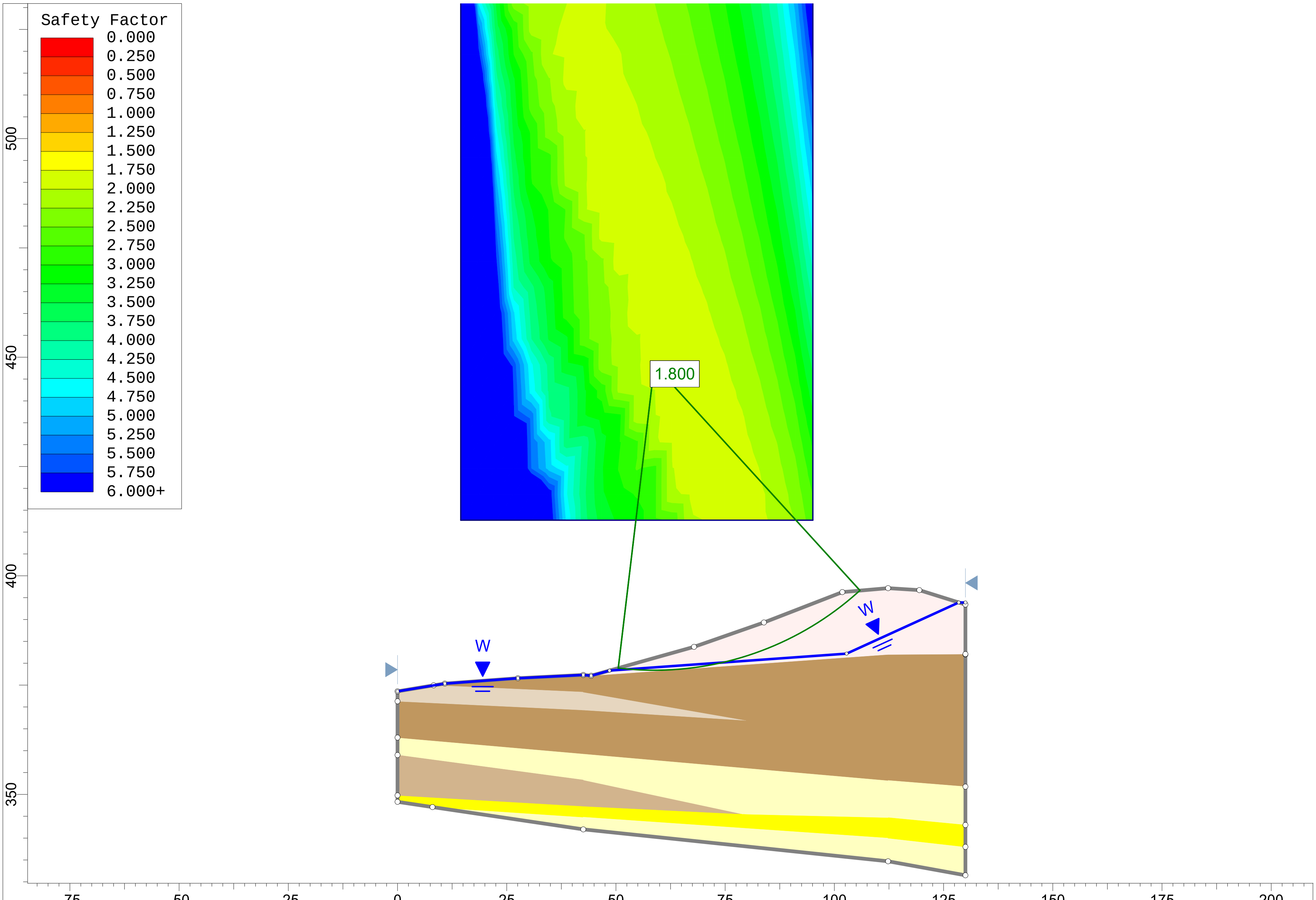
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | File Name | GR-2.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 123.45 | 395.483 |
| 130 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

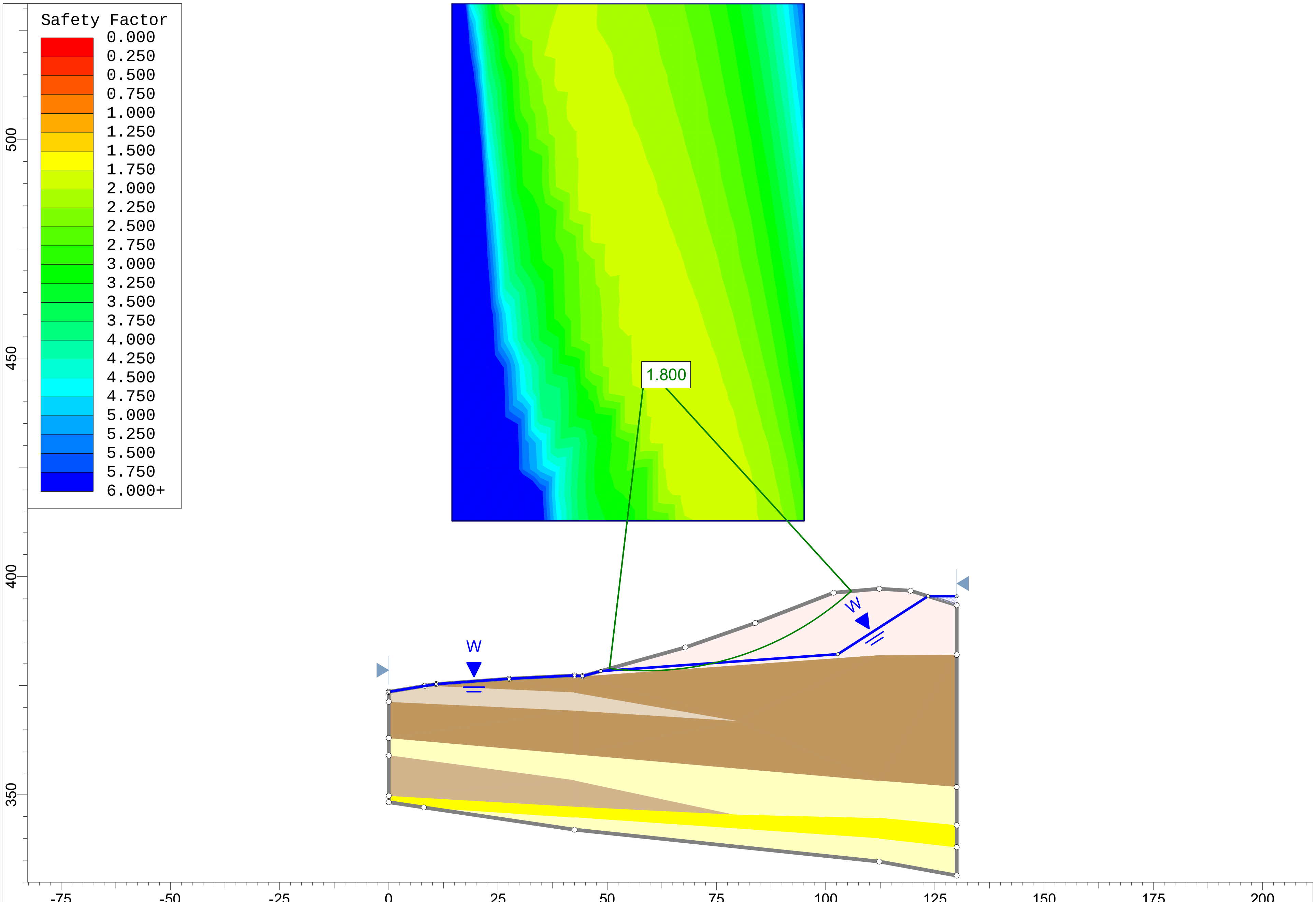
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




SLIDEINTERPRET 6.039

| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | | File Name GR-2 Surcharge.slim |

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |

| | |
|---|---|
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |

| | |
|---|---|
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

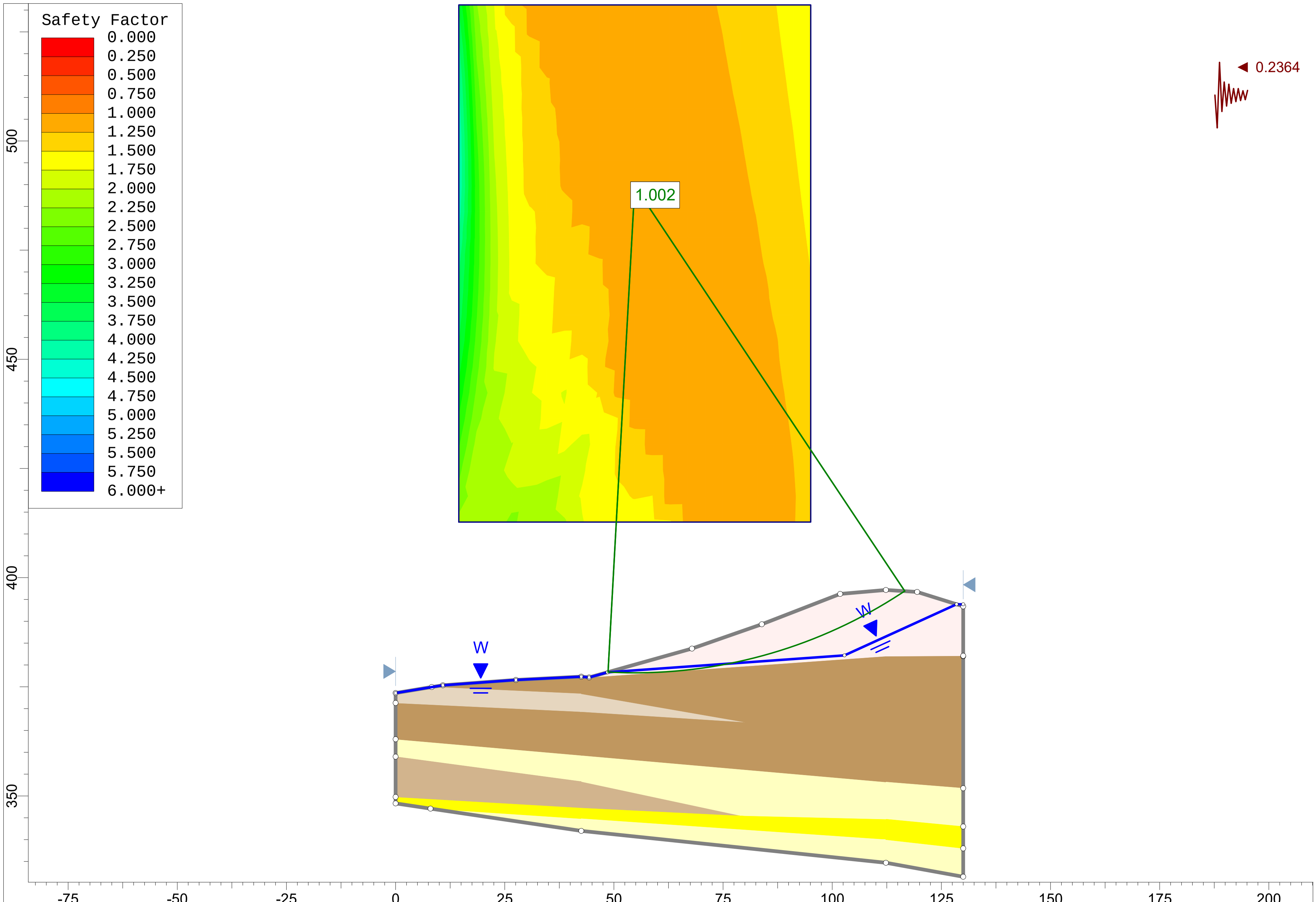
## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |

| | | | |
|---|---|---|---|
| SLIDE 6.039 | *Project* BREC Green Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section GR-2 Seismic Loading Condition | | |
| | *Drawn By* | *Scale* | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 3:56:57 PM | | *File Name* GR-2 Seis 2.slim |




| | |
|---|---|
| Project | BREC Green Station CCR Surface Impoundment |
| Analysis Description | Cross Section GR-2 Seismic Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM |
| File Name | GR-2 Seis 2.slim |

SLIDEINTERPRET 6.039

# *Slide Analysis Information*

# *BREC Green Station CCR Surface Impoundment*

## *Project Summary*

File Name: GR-2 Liq
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## *General Settings*

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## *Analysis Options*

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## *Groundwater Analysis*

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 0 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

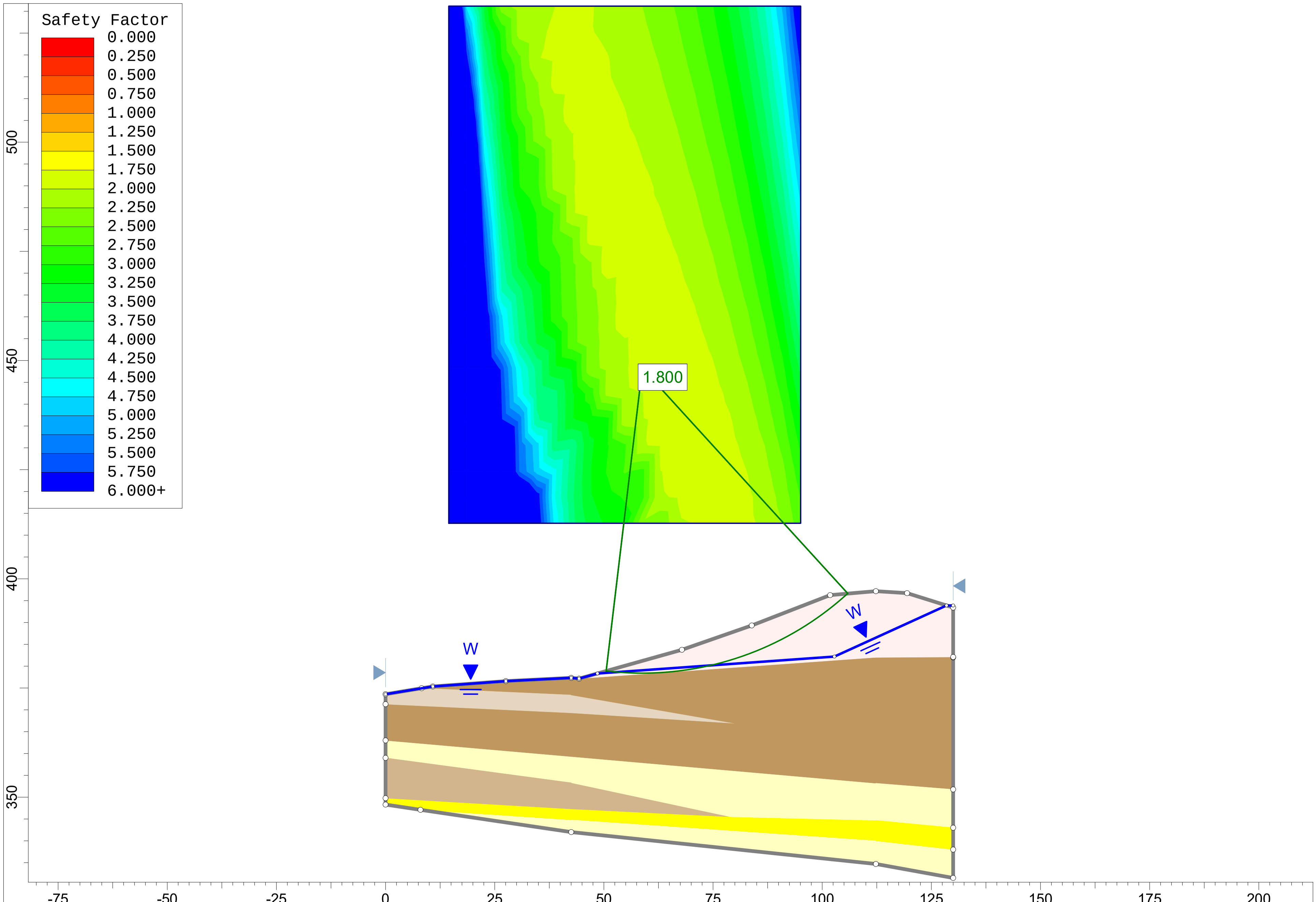
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | |
|---|---|
| Project | BREC Green Station CCR Surface Impoundment |
| Analysis Description | Cross Section GR-2 Liquefaction Condition |
| Drawn By | Scale: 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM |
| File Name | GR-2 Liq.slim |

SLIDEINTERPRET 6.039

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

# Green Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

**Project ID: 160028A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Green Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0980 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
>
> 3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

**From: VI. Development of the Final Rule - Technical Requirements**

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface

impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

<u>The Calculated Liquefaction Factor of Safety</u>

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

<u>Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment</u>

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

## <u>**Description of Impoundment**</u>

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit has been in place for 40 plus years. The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant 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. The toe of the outboard slope intersected a lower drainage area. 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.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 16 feet and 46 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 394 feet and 408 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 172,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 981,000 cubic yards (approximate water volume is 172,000 cubic yards and approximate CCR volume is 809,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of two corrugated steel pipes, each 30 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

**Calculated Safety Factors**

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Green CCR impoundment are attached to this report.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 1.800

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 1.800

3. The calculated seismic factor of safety equals: 1.002

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.800

**Sources of Information**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Green CCR Impoundment Initial Safety Factor Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.
State of Kentucky License No. 17822

Date: 10/11/16


Attachment A. Aerial Photo of the Green CCR Surface Impoundment


Attachment B.  Topographic Map showing the Green CCR Surface Impoundment

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |

| | |
|---|---|
| 170.48 | 366.698 |

## Material Boundary

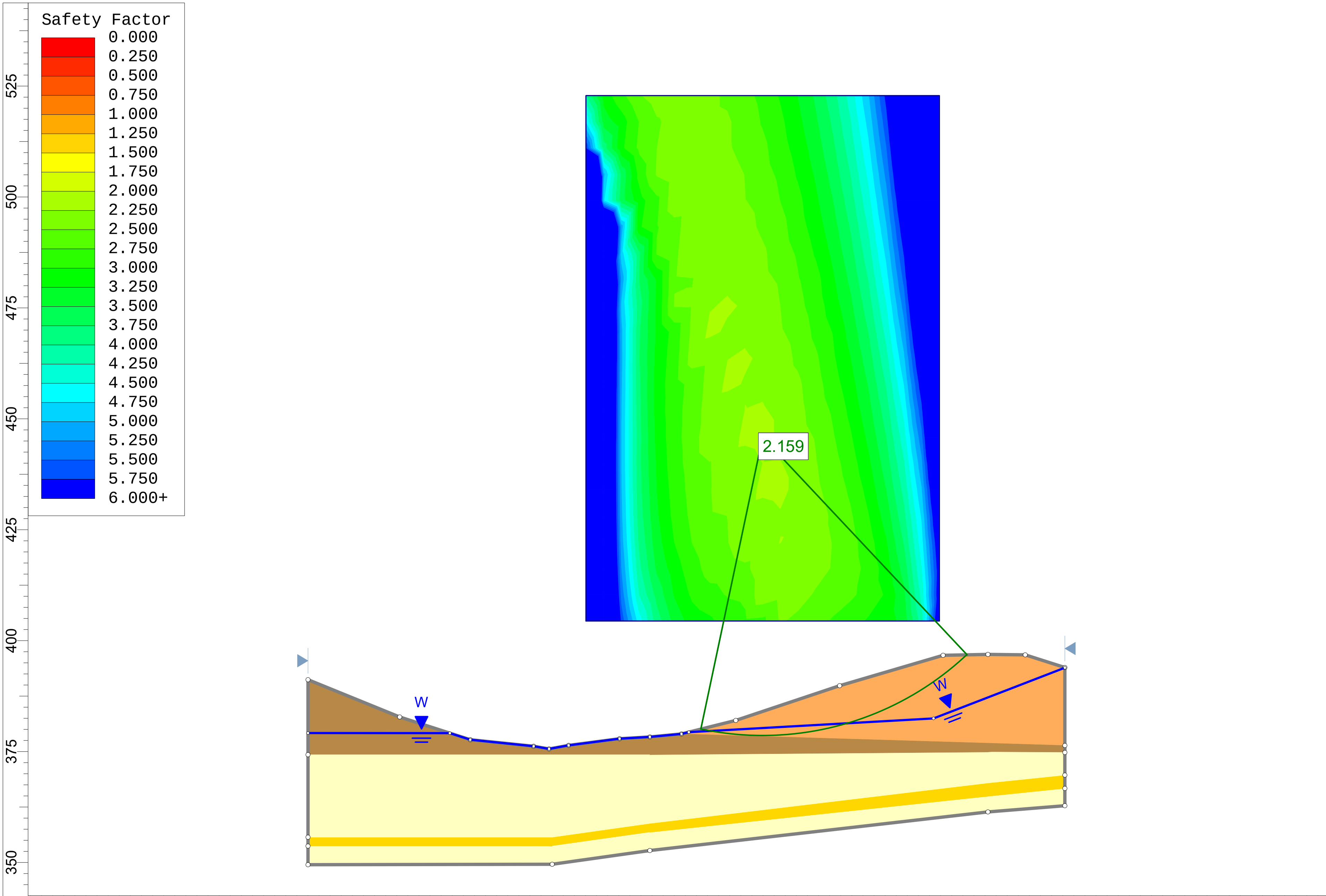
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc |
| Date | 9/5/2016, 3:43:18 PM | File Name | GR-1.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy lean clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |

| | |
|---|---|
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 165.719 | 395.483 |
| 170.48 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |

| | |
|---|---|
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

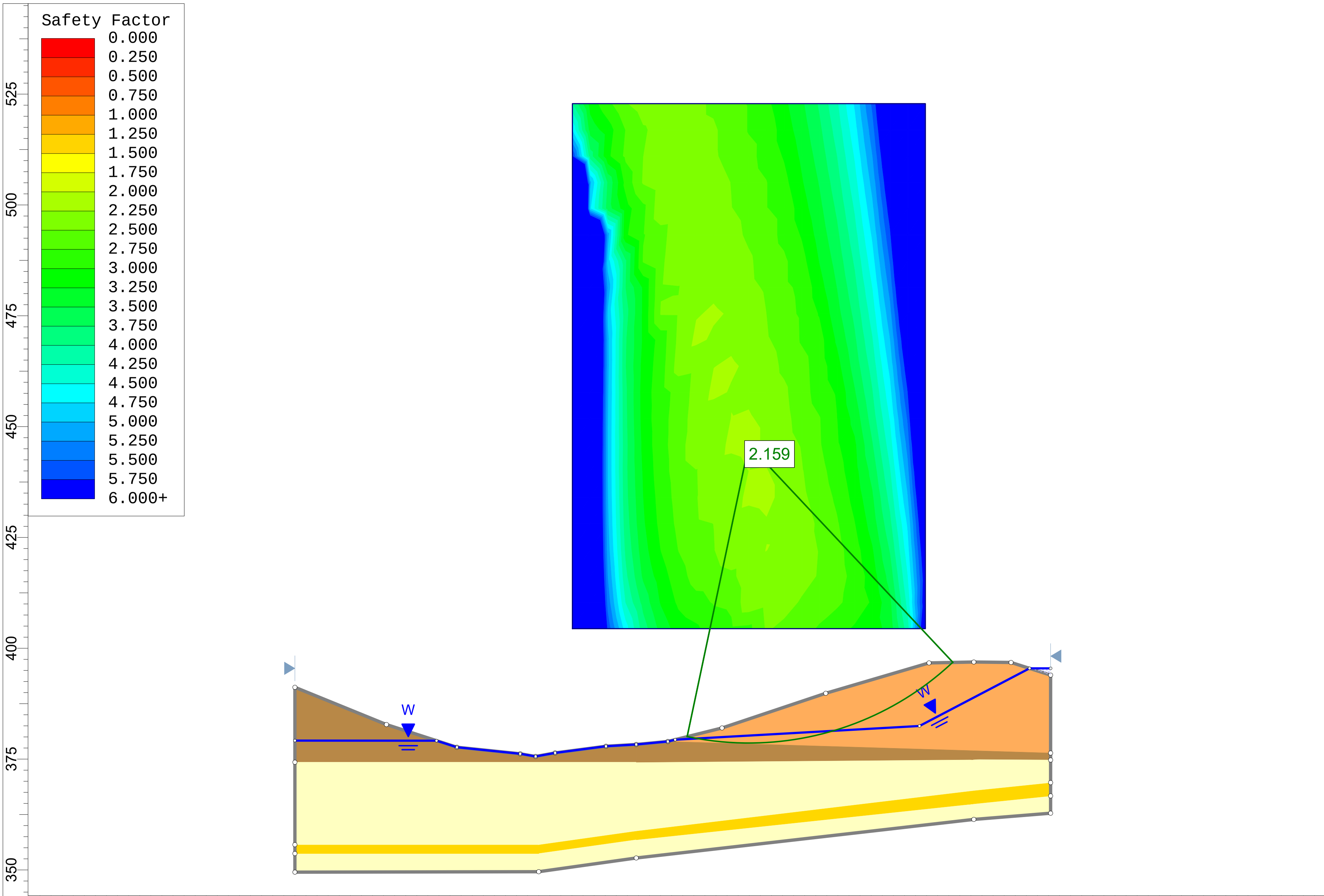
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | | Scale: 1:360 | Company: Associated Engineers, Inc |
| Date | 9/5/2016, 3:43:18 PM | File Name | GR-1 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Seismic Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean clay (CL) | Sandy Lean Clay With Gravel (CL) (Dam) |
|---|---|---|---|---|
| Color | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 134.3 | 135.4 | 137.69 |
| Cohesion [psf] | 316.8 | 403.2 | 820.8 | 72 |
| Friction Angle [deg] | 24.3 | 30.2 | 24.6 | 27.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 379.185 |
| 31.955 | 379.172 |
| 36.551 | 377.695 |
| 50.832 | 376.221 |
| 54.305 | 375.6 |

| | |
|---|---|
| 58.684 | 376.406 |
| 70.171 | 377.906 |
| 76.996 | 378.317 |
| 84.12 | 378.983 |
| 85.7592 | 379.391 |
| 140.9 | 382.48 |
| 170.48 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 0 | 349.5 |
| 55 | 349.6 |
| 77 | 352.7 |
| 153.14 | 361.4 |
| 170.48 | 362.8 |
| 170.48 | 366.698 |
| 170.48 | 369.698 |
| 170.48 | 374.816 |
| 170.48 | 376.396 |
| 170.48 | 393.967 |
| 161.556 | 396.809 |
| 153.137 | 396.9 |
| 143.057 | 396.719 |
| 119.757 | 389.859 |
| 96.35 | 382.029 |
| 84.12 | 378.983 |
| 76.996 | 378.317 |
| 70.171 | 377.906 |
| 58.684 | 376.406 |
| 54.305 | 375.6 |
| 50.832 | 376.221 |
| 36.551 | 377.695 |
| 20.651 | 382.805 |
| 0 | 391.212 |
| 0 | 374.3 |
| 0 | 355.7 |
| 0 | 353.7 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 353.7 |
| 55 | 353.7 |
| 77 | 356.8 |
| 153 | 364.9 |
| 170.48 | 366.698 |

## Material Boundary

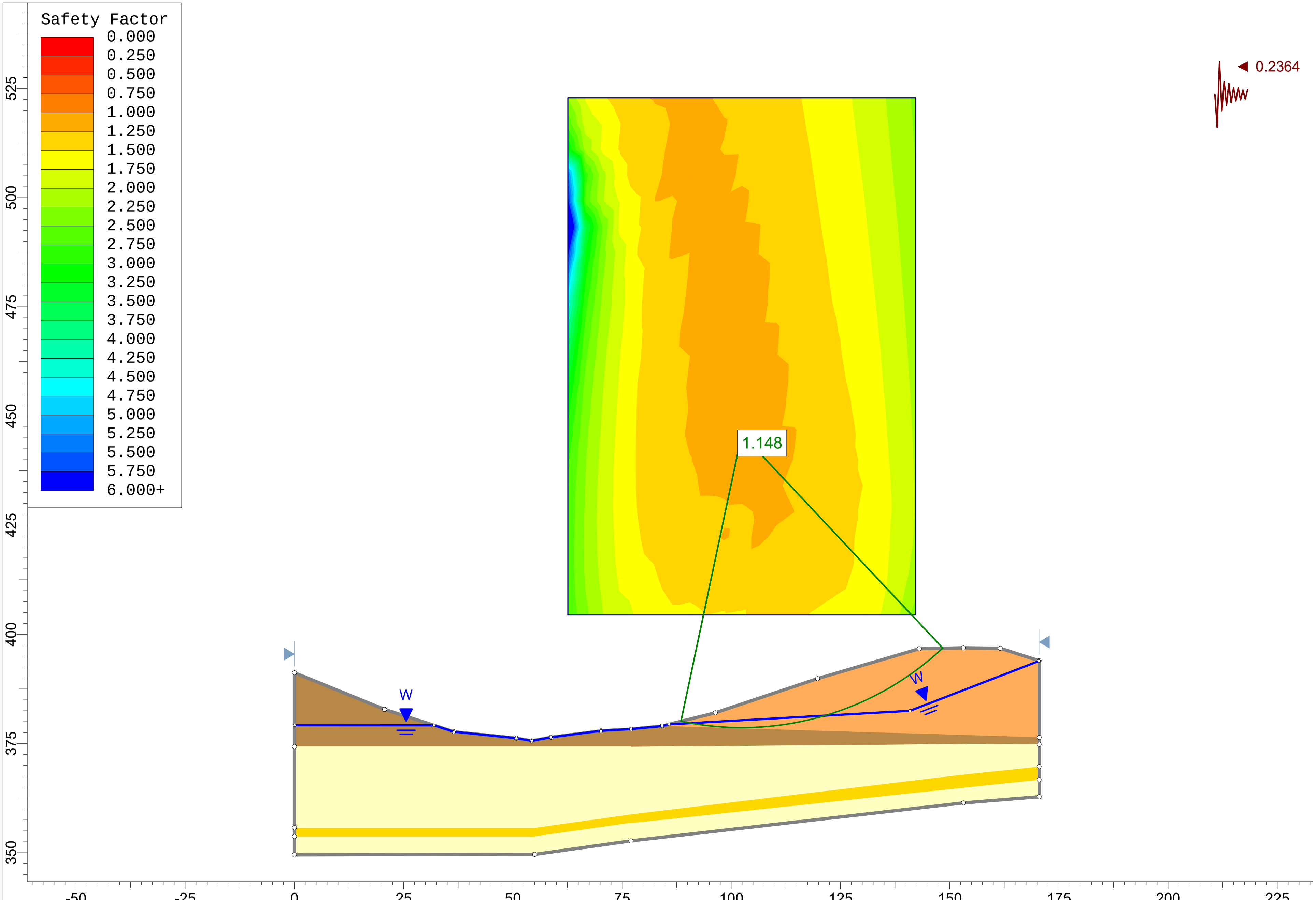
| X | Y |
|---|---|
| 0 | 355.7 |
| 55 | 355.7 |
| 77 | 358.8 |
| 153 | 367.9 |
| 170.48 | 369.698 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 374.3 |
| 77 | 374.3 |
| 153 | 374.9 |
| 170.48 | 374.816 |

## Material Boundary

| X | Y |
|---|---|
| 84.12 | 378.983 |
| 153 | 376.9 |
| 170.48 | 376.396 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-1 Seismic Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc |
| Date 9/5/2016, 3:43:18 PM | | File Name | GR-1 Seis.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

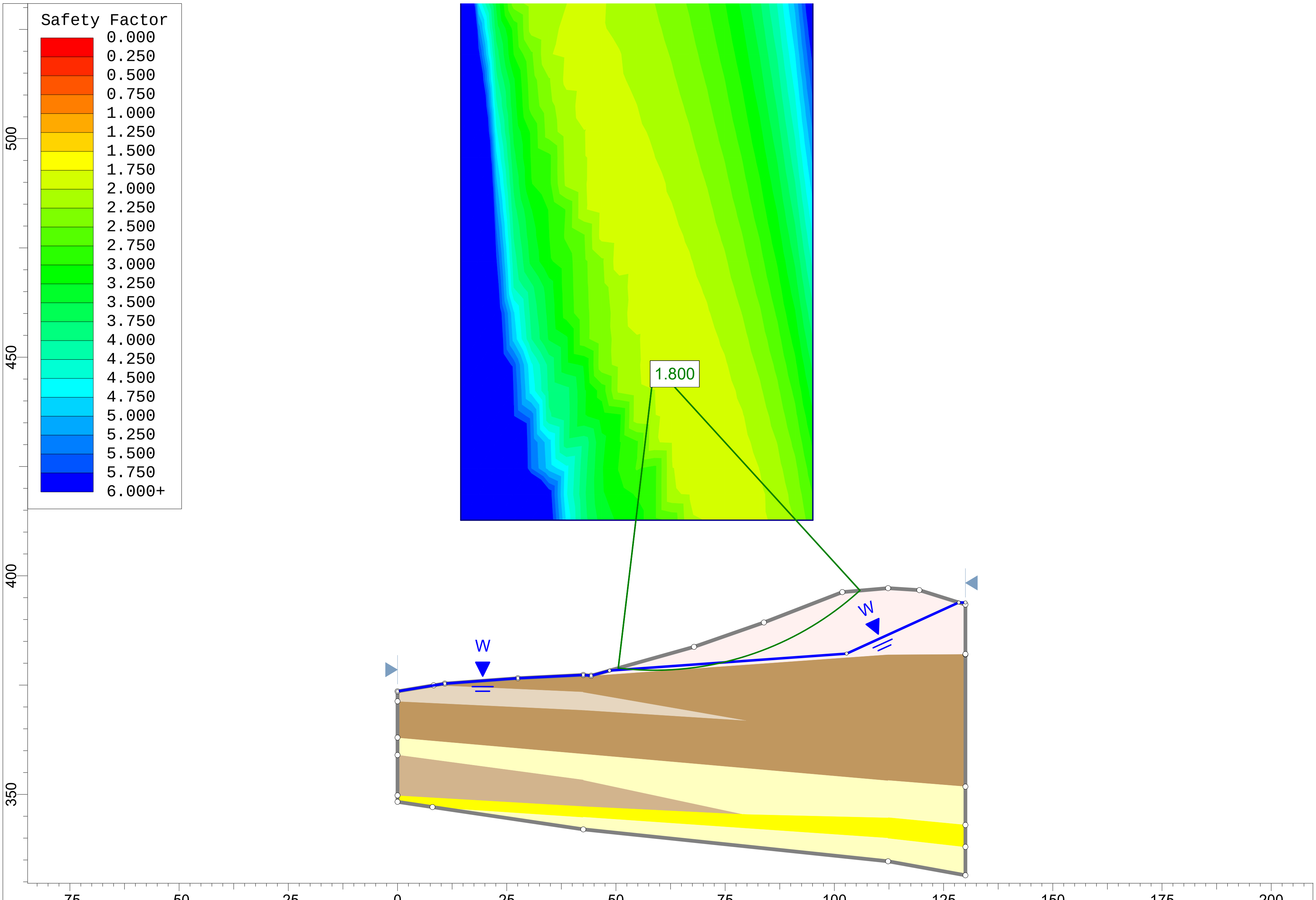
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | |
|---|---|
| Project | BREC Green Station CCR Surface Impoundment |
| Analysis Description | Cross Section GR-2 Maximum Storage Pool Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM |
| File Name | GR-2.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 123.45 | 395.483 |
| 130 | 395.48 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

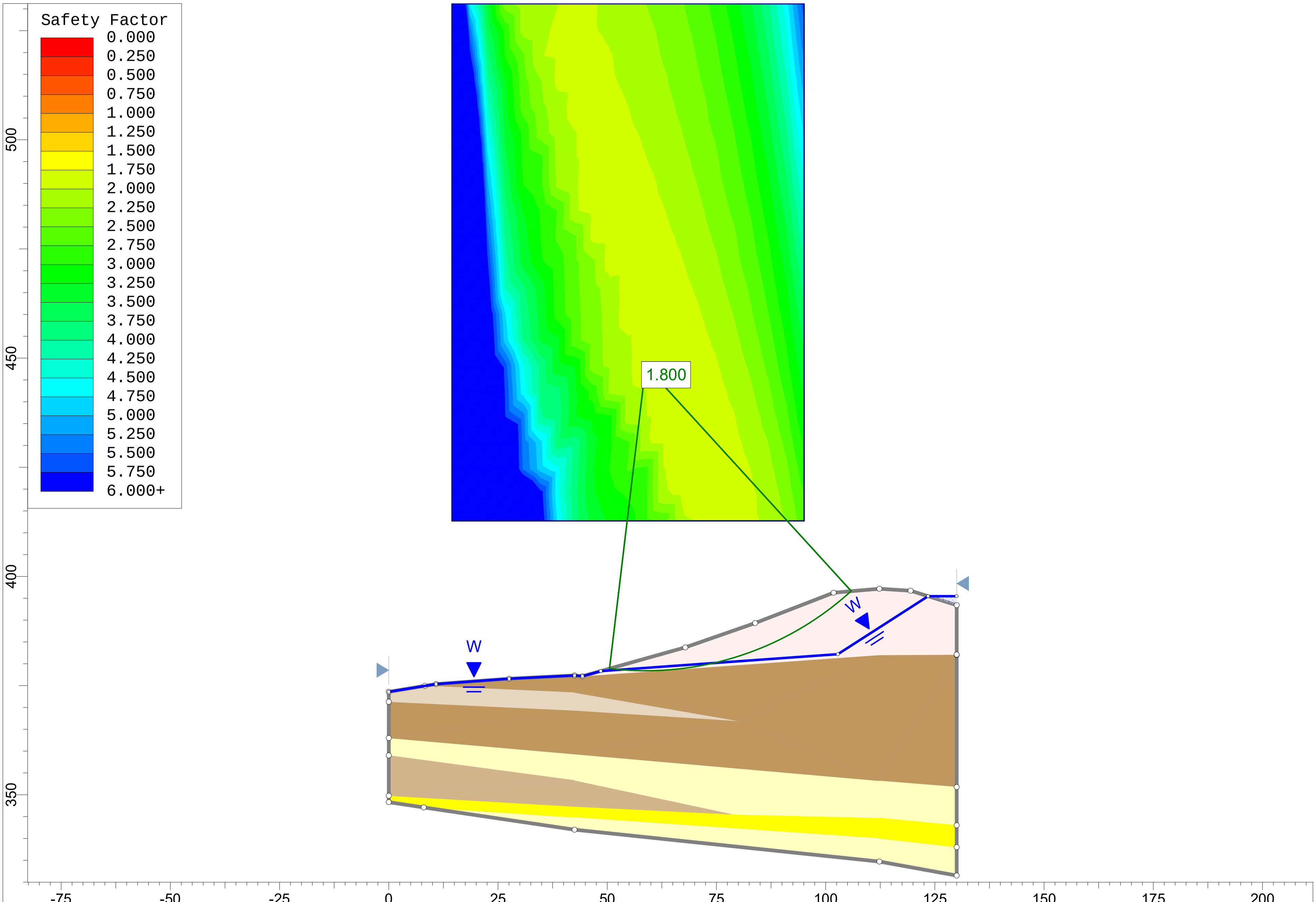
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date 9/5/2016, 3:56:57 PM | | File Name | GR-2 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2364

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 33 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |

| | |
|---|---|
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |

| | |
|---|---|
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

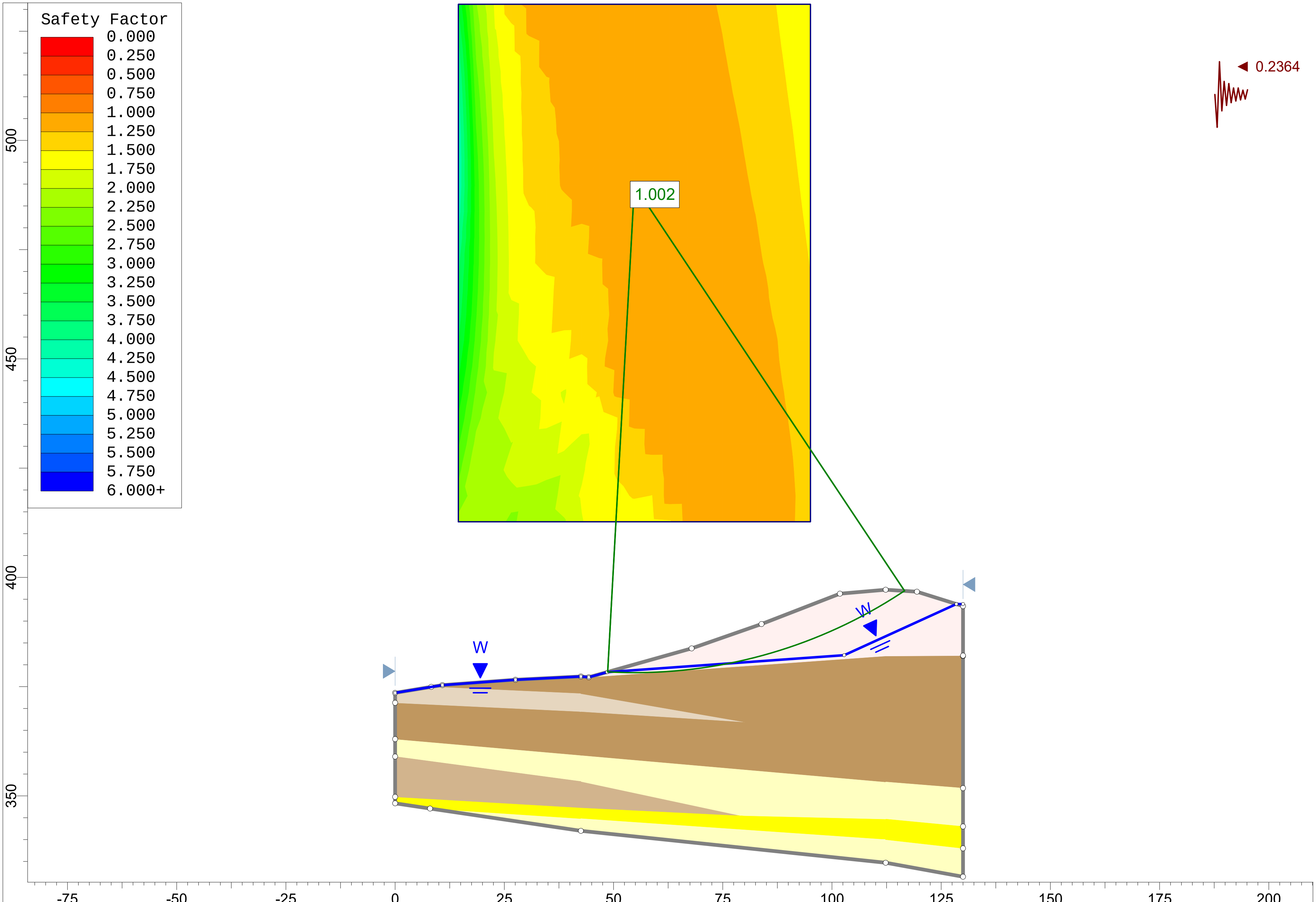
## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |

| | | | |
|---|---|---|---|
| SLIDE 6.039 | *Project* BREC Green Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section GR-2 Seismic Loading Condition | | |
| | *Drawn By* | *Scale* | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 3:56:57 PM | | *File Name* GR-2 Seis 2.slim |




| | | | |
|---|---|---|---|
| Project | BREC Green Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section GR-2 Seismic Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:56:57 PM | File Name | GR-2 Seis 2.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Green Station CCR Surface Impoundment

## Project Summary

File Name: GR-2 Liq
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Poorly Graded Sand With Silt (SP-SM) | Lean Clay with Sand (CL) | Lean clay (CL) | Lean Clay With Sand 2 | Lean clay With Sand (Dam) |
|---|---|---|---|---|---|---|
| Color | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128.1 | 126 | 131.9 | 135.4 | 126.6 | 140.6 |
| Cohesion [psf] | 316.8 | 0 | 374 | 820.8 | 0 | 72 |
| Friction Angle [deg] | 24.3 | 0 | 27.7 | 24.6 | 30.8 | 24.1 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 373.571 |
| 10.818 | 375.37 |
| 27.54 | 376.571 |
| 42.515 | 377.335 |
| 44.31 | 377.146 |
| 48.515 | 378.327 |
| 102.8 | 382.2 |

| | |
|---|---|
| 128.457 | 393.92 |
| 130 | 393.92 |

## External Boundary

| X | Y |
|---|---|
| 3.298e-013 | 348.3 |
| 7.98633 | 347.116 |
| 42.51 | 342 |
| 112.29 | 334.7 |
| 130 | 331.5 |
| 130 | 338 |
| 130 | 343 |
| 130 | 351.773 |
| 130 | 382.006 |
| 130 | 382.1 |
| 130 | 393.439 |
| 119.451 | 396.731 |
| 112.288 | 397.189 |
| 101.806 | 396.285 |
| 83.858 | 389.332 |
| 67.857 | 383.758 |
| 44.31 | 377.146 |
| 42.515 | 377.335 |
| 27.54 | 376.571 |
| 10.818 | 375.37 |
| 8.27071 | 374.946 |
| 0 | 373.571 |
| 0 | 371.3 |
| 0 | 363 |
| 0 | 359 |
| 3.10558e-013 | 349.774 |

## Material Boundary

| X | Y |
|---|---|
| 7.98633 | 347.116 |
| 42.5 | 344.8 |
| 112.2 | 340 |
| 130 | 338 |

## Material Boundary

| X | Y |
|---|---|
| 3.10558e-013 | 349.774 |
| 42.5 | 347.3 |
| 79 | 345.5 |
| 112.2 | 344.7 |
| 130 | 343 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 359 |
| 42.5 | 353.3 |
| 79 | 345.5 |

## Material Boundary

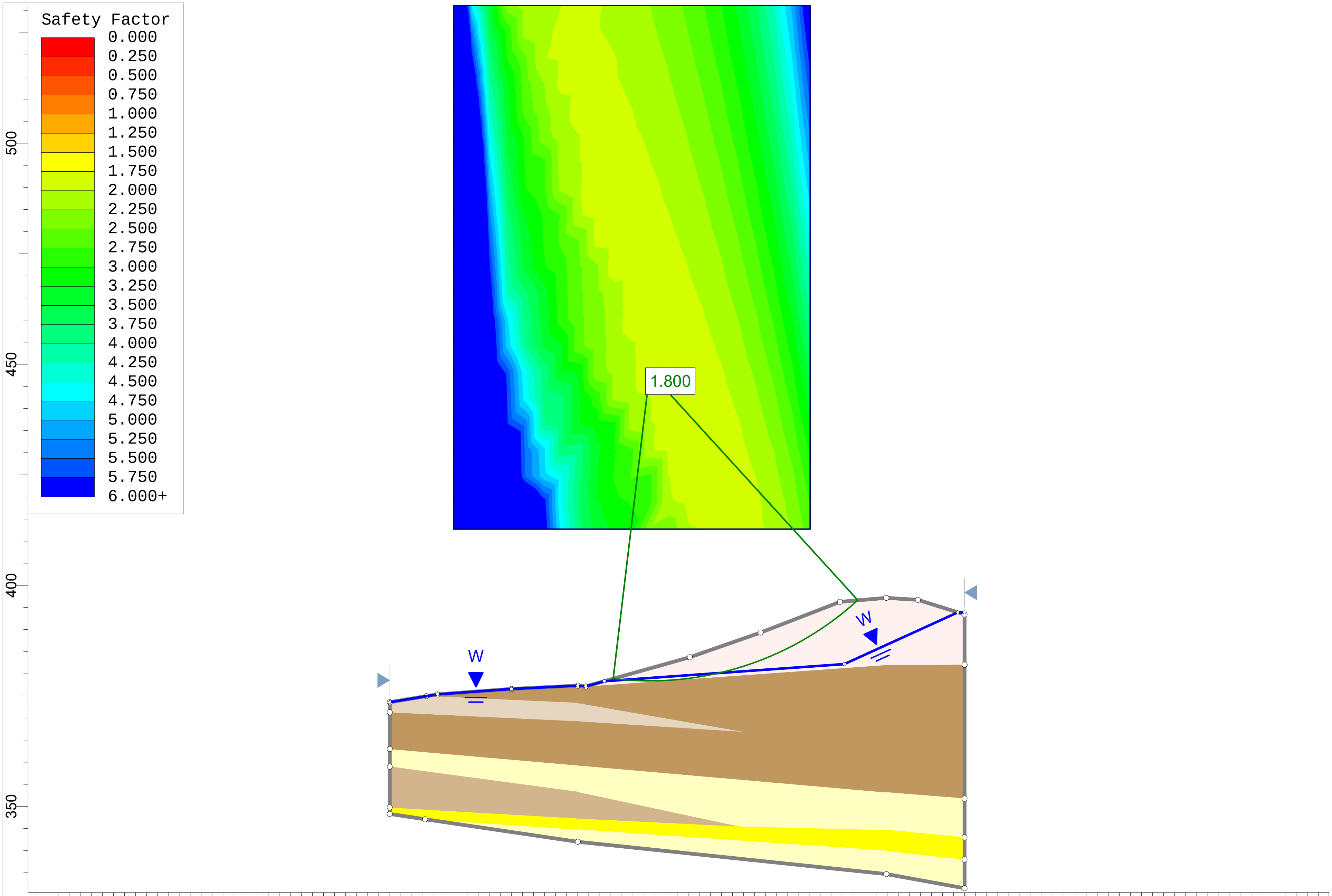
| X | Y |
|---|---|
| 0 | 363 |
| 42.5 | 359.3 |
| 112.2 | 353.2 |
| 130 | 351.773 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 371.3 |
| 42.5 | 369.3 |
| 80 | 366.9 |
| 42.5 | 373.4 |
| 8.27071 | 374.946 |

## Material Boundary

| X | Y |
|---|---|
| 44.31 | 377.146 |
| 112.2 | 382 |
| 130 | 382.1 |




| | | | |
|---|---|---|---|
| *Project* | BREC Green Station CCR Surface Impoundment | | |
| *Analysis Description* | Cross Section GR-2 Liquefaction Condition | | |
| *Drawn By* | | *Scale* 1:360 | *Company* Associated Engineers, Inc. |
| *Date* | 9/5/2016, 3:56:57 PM | | *File Name* GR-2 Liq.slim |

SLIDEINTERPRET 6.039

Big Rivers
ELECTRIC CORPORATION
Your Touchstone Energy® Cooperative

# Reid/HMPL Station CCR Surface Impoundment

**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

**October 11, 2016**

**Prepared By:**

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

**Project ID: 160027A**

**Big Rivers Electric Corporation**
**Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule**
**Structural Integrity Criteria for Existing CCR Surface Impoundments**
**Initial Safety Factor Assessment**

## CCR Surface Impoundment Information

| | |
|---|---|
| Name: | Reid/HMPL Station CCR Surface Impoundment |
| Operator: | Sebree Generating Station |
| Address: | 9000 Highway 2096<br>Robards, Kentucky 42452 |
| CCR Unit Identification Number: | Kentucky State Dam Inventory System ID No. 0855 |

## Qualified Professional Engineer

| | |
|---|---|
| Name: | David A. Lamb |
| Company: | Associated Engineers, Inc. |
| Kentucky P.E. Number: | 17822 |

## Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

**From: VI. Development of the Final Rule - Technical Requirements**

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

The Calculated Liquefaction Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

## Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary.  There are no known occurrences of structural instability of the CCR unit.

The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash.  The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 25.45 acres in size.  The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure.  Embankments form the west, south and east sides of the impoundment and the north side is incised.  The original terrain on which the pond was constructed generally sloped toward the west.  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.

The embankment reaches its greatest relief of approximately 42 feet on the west side.  The Burns & McDonnell Engineering Co. October 8, 1971 design drawings show the inboard slope and central core portion of the dike to be constructed of compacted soil fill and the outboard slope to be consisted of sand fill.  A sand blanket drain was designed for the outboard third of the base of the dike for the majority of the length and the plans show a crushed limestone drainage layer with a minimum thickness of 18 inches topped with a minimum six inches thick sand layer which extends across the entire width of the dike cross section in the southwest corner.  The plans also show a cut-off trench in the original ground below dike crest and extending for the entire length of the dike.

Depth of impounded water and CCR is 16 feet and 39 feet (at respective locations of maximum impounded water and CCR depths).  Elevation of impounded water and CCR is 426 feet and 440 feet, respectively, above mean sea level.  These approximate depths and respective elevations are based on the most recent (December 2015) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 85,000 cubic yards (if CCR can be placed to the elevation of the current water surface).  This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 767,000 cubic yards (approximate water volume is 85,000 cubic yards and approximate CCR volume is 682,000 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.
The impoundment discharge consists of a rectangular concrete drop structure with a variable

height steel debris skimmer. The pool elevation can be controlled by adding or removing stop logs. The discharge structure connects to a 24-inch diameter smooth walled metal pipe underground conveyance.

**Calculated Safety Factors**

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Reid/HMPL CCR impoundment are attached to this report.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 2.053

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 2.052

3. The calculated seismic factor of safety equals: 1.075

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.585

**Sources of Information**

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

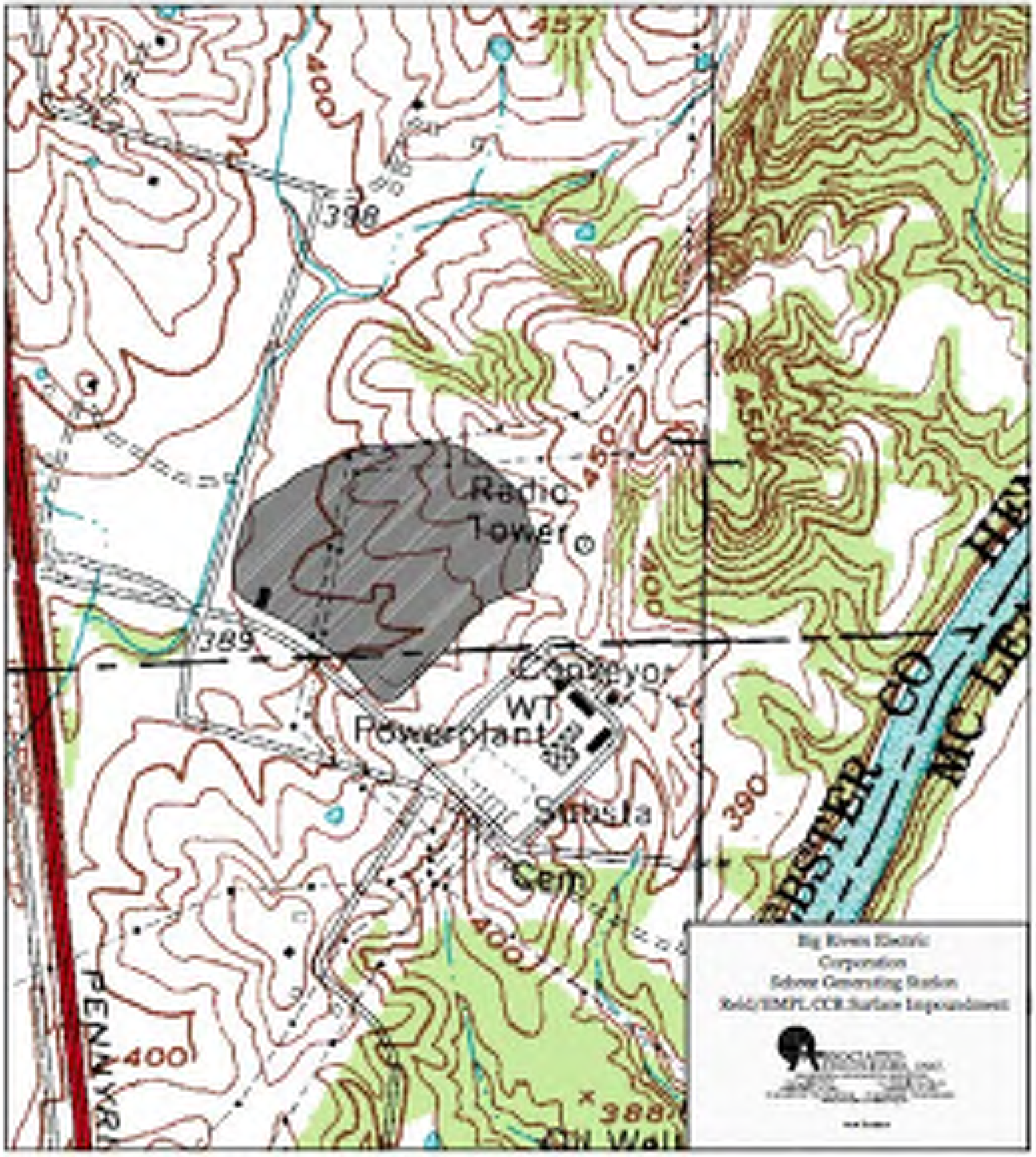
**Professional Engineer Certification [Per 40 CFR § 257.73]**
**Reid/HMPL CCR Impoundment Initial Safety Factor Assessment**

I hereby certify that myself or an agent under my review has prepared this Initial Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.
State of Kentucky License No. 17822

Date: 10/11/16


Attachment A.  Aerial Photo of the Reid/HMPL CCR Surface Impoundment




Attachment B. Topographic Map showing the Reid/HMPL CCR Surface Impoundment

# Slide Analysis Information

# Big Rivers Electric Corporation

## Project Summary

File Name: RH-1
Last saved with Slide version: 6.039
Project Title: Big Rivers Electric Corporation
Analysis: Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

### Material Boundary

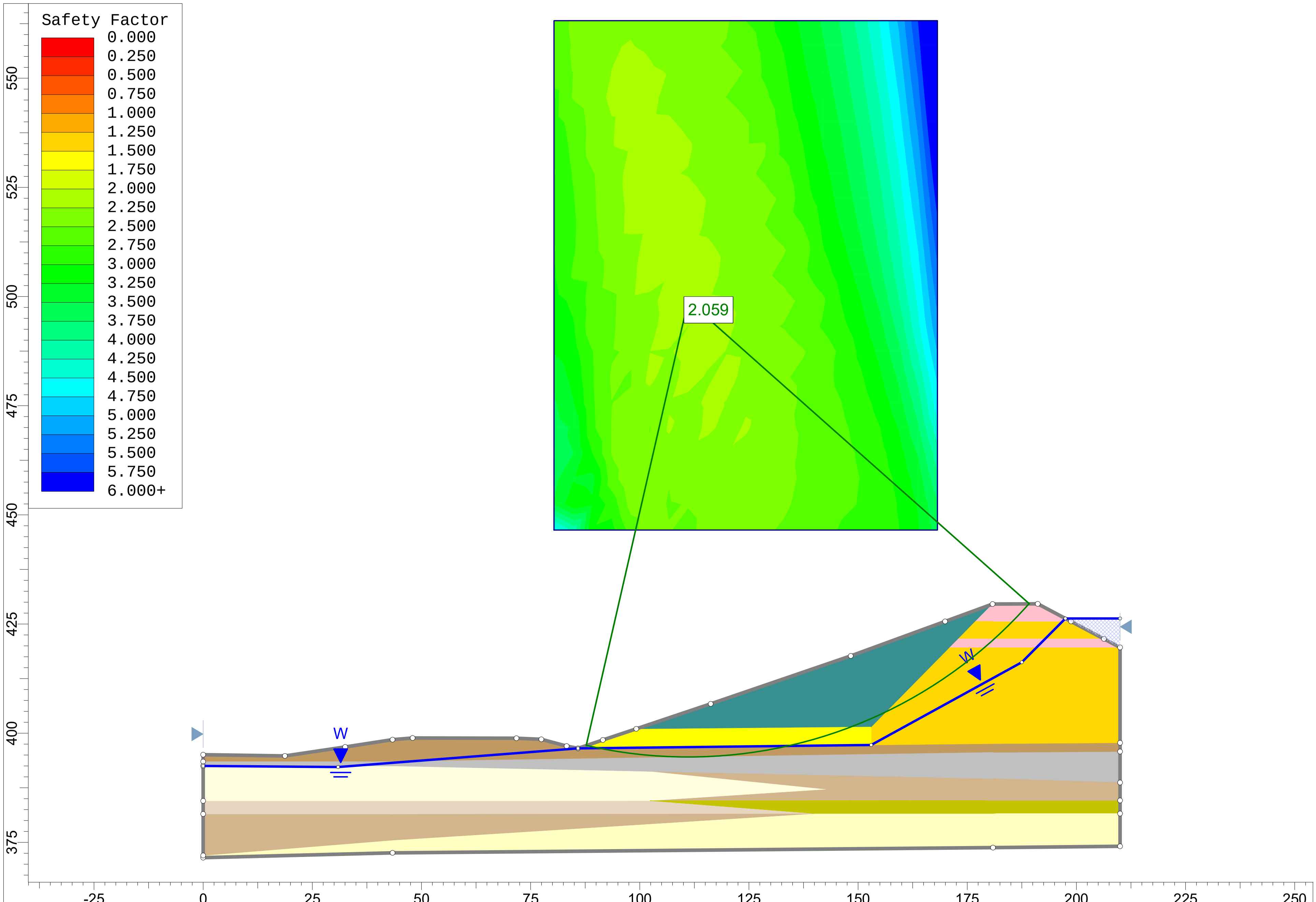
| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

### Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

### Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |




| | |
|---|---|
| Project | Big Rivers Electric Corporation |
| Analysis Description | Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 2:31:54 PM |
| File Name | RH-1.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 194.956 | 427.61 |
| 210 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

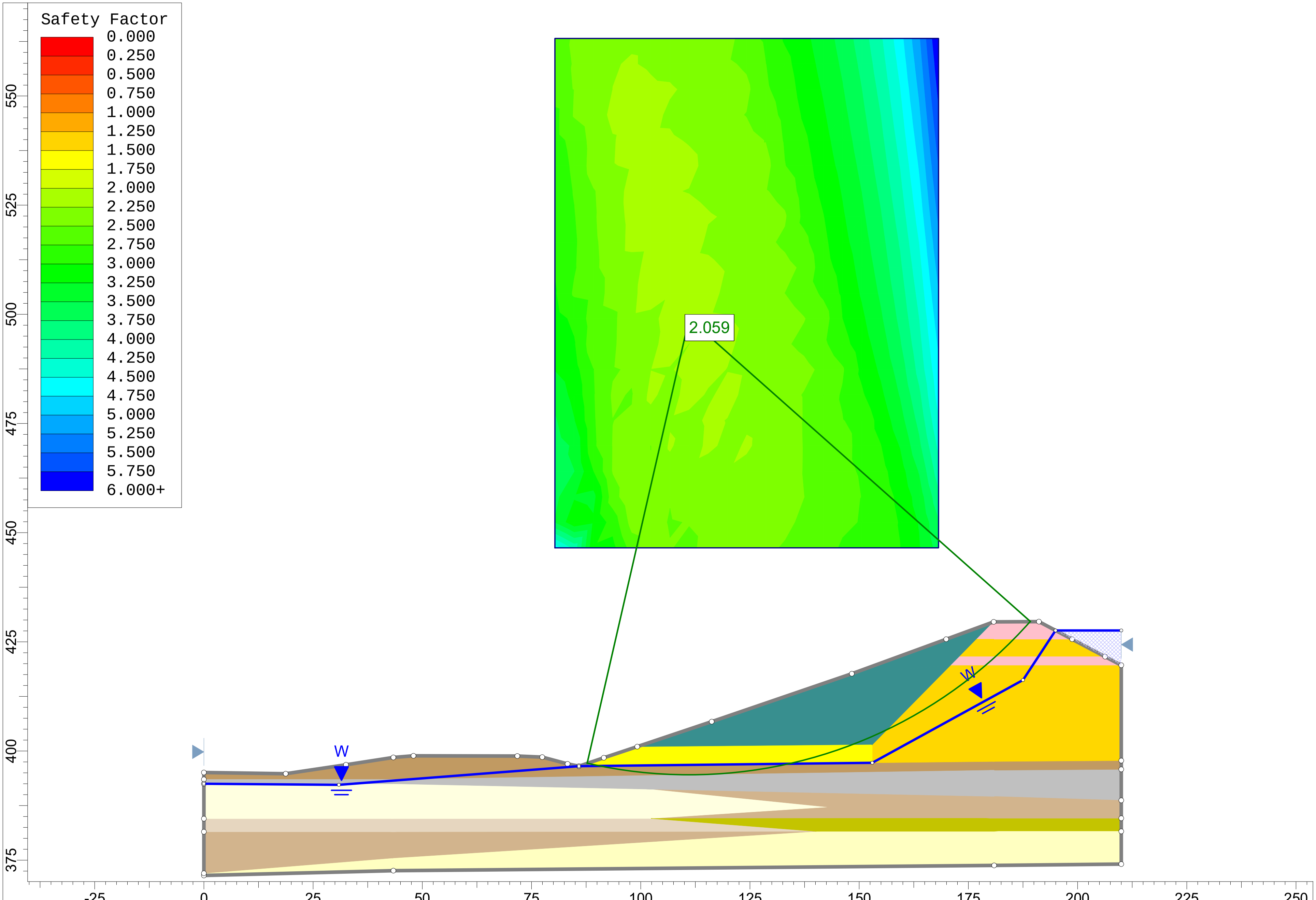
## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |

| | | | |
|---|---|---|---|
| rocscience<br>SLIDE 6.039 | *Project* BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section RH-1 Maximum Surcharge Pool Loading Condition | | |
| | *Drawn By* | *Scale* | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 2:31:54 PM | | *File Name* RH-1 Surcharge.slim |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-1 Maximum Surcharge Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 2:31:54 PM | | File Name RH-1 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 72 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 31 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

## Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |

| | |
|---|---|
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

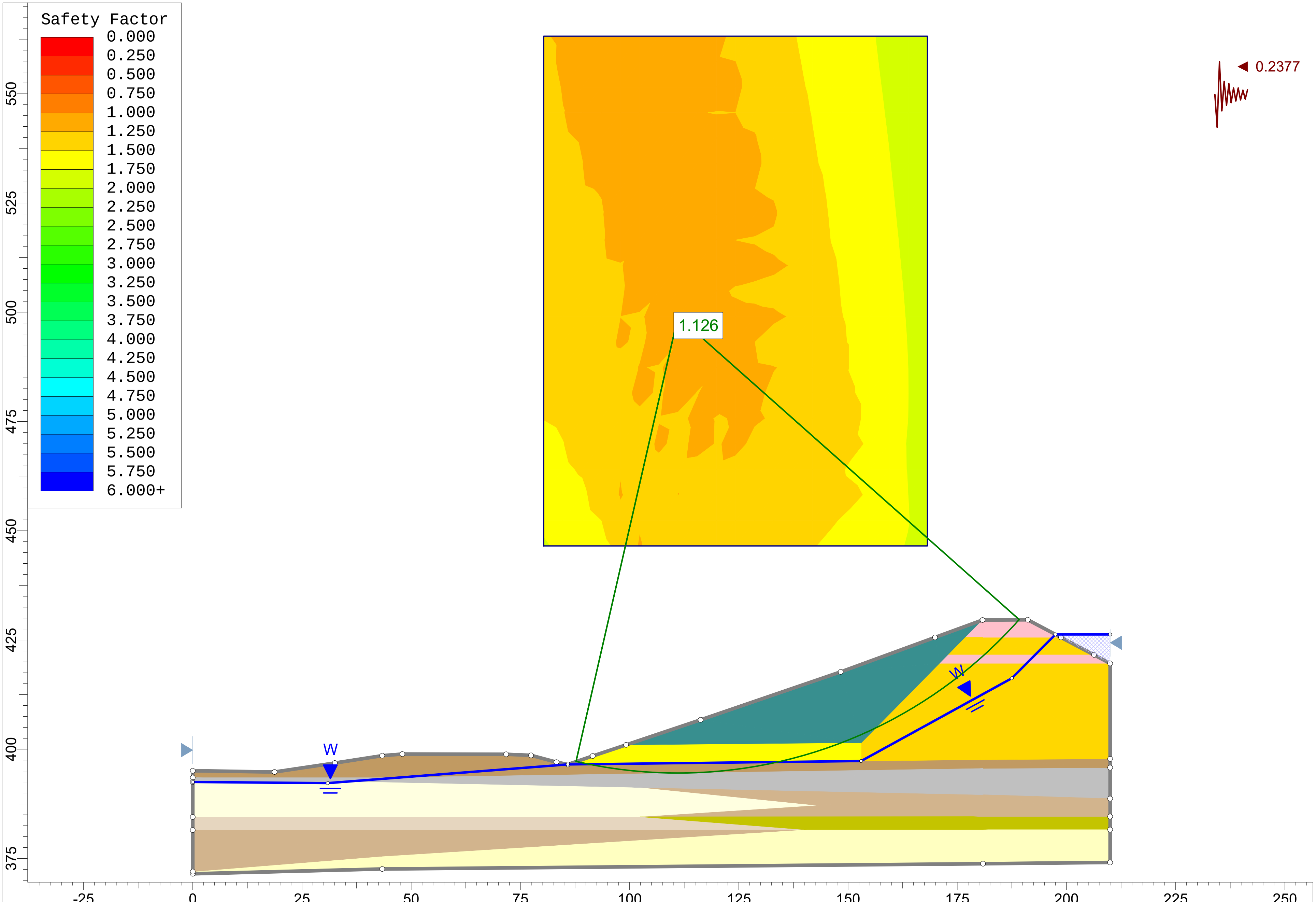
| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |




| | | | |
|---|---|---|---|
| *Project* | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| *Analysis Description* | Cross Section RH-1 Seismic Loading Condition | | |
| *Drawn By* | *Scale* 1:360 | *Company* | Associated Engineers, Inc. |
| *Date* 9/5/2016, 2:31:54 PM | | *File Name* | RH-1 Seis.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-1 Seis Liq
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Lean Clay (CL) | Lean Clay (CL), Silty | Silt With Sand (ML) | Silty Clay (CL-ML) | Lean Clay (CL) 2 | Sandy Lean Clay (Dam) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 126 | 123 | 125.8 | 129.7 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 72 | 0 | 200 | 14.4 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 30.4 | 0 | 33.7 | 28.7 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material (Dam) | Silty Sand (SM) | Sandy Lean Clay (CL) 2 |
|---|---|---|---|
| Color | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 130 | 124.6 |
| Cohesion [psf] | 200 | 0 | 740 |
| Friction Angle [deg] | 30 | 33 | 23.2 |
| Water Surface | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 392.5 |
| 30.9 | 392.24 |
| 85.846 | 396.532 |

| | |
|---|---|
| 153 | 397.3 |
| 187.5 | 416.24 |
| 197.467 | 426.28 |
| 210 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 0 | 371.5 |
| 43.37 | 372.6 |
| 180.89 | 373.8 |
| 210 | 374.1 |
| 210 | 381.6 |
| 210 | 384.6 |
| 210 | 388.7 |
| 210 | 395.8 |
| 210 | 397.8 |
| 210 | 419.644 |
| 206.306 | 421.6 |
| 198.751 | 425.6 |
| 191.136 | 429.632 |
| 180.794 | 429.579 |
| 169.909 | 425.6 |
| 148.327 | 417.711 |
| 116.257 | 406.72 |
| 99.1875 | 401.002 |
| 91.5524 | 398.444 |
| 85.846 | 396.532 |
| 83.24 | 397.044 |
| 77.457 | 398.595 |
| 71.748 | 398.856 |
| 47.962 | 398.89 |
| 43.367 | 398.519 |
| 32.528 | 396.852 |
| 18.716 | 394.794 |
| 0 | 395.066 |
| 0 | 393.5 |
| 0 | 392.5 |
| 0 | 384.5 |
| 0 | 381.5 |
| 0 | 372 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 0 | 372 |
| 43.3 | 375.5 |
| 140 | 381.6 |
| 180.9 | 381.6 |
| 210 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 381.5 |
| 43.3 | 381.5 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 384.5 |
| 43.3 | 384.5 |
| 102.292 | 384.543 |
| 180 | 384.6 |
| 210 | 384.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 392.5 |
| 43.3 | 392.5 |
| 102.672 | 391.249 |
| 180.9 | 389.6 |
| 210 | 388.7 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 393.5 |
| 43.3 | 393.5 |
| 180.9 | 395.6 |
| 210 | 395.8 |

## Material Boundary

| X | Y |
|---|---|
| 85.846 | 396.532 |
| 153 | 397.3 |
| 180.9 | 397.6 |

| | |
|---|---|
| 210 | 397.8 |

## Material Boundary

| X | Y |
|---|---|
| 99.1875 | 401.002 |
| 153 | 401.5 |
| 153 | 401.333 |
| 153 | 401.333 |
| 153 | 397.3 |

## Material Boundary

| X | Y |
|---|---|
| 153 | 401.333 |
| 171.018 | 419.644 |
| 172.943 | 421.6 |
| 176.879 | 425.6 |
| 180.794 | 429.579 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 425.6 |
| 198.751 | 425.6 |

## Material Boundary

| X | Y |
|---|---|
| 172.943 | 421.6 |
| 180.9 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 180.9 | 421.6 |
| 206.306 | 421.6 |

## Material Boundary

| X | Y |
|---|---|
| 171.018 | 419.644 |
| 210 | 419.644 |
| 180.9 | 419.6 |

## Material Boundary

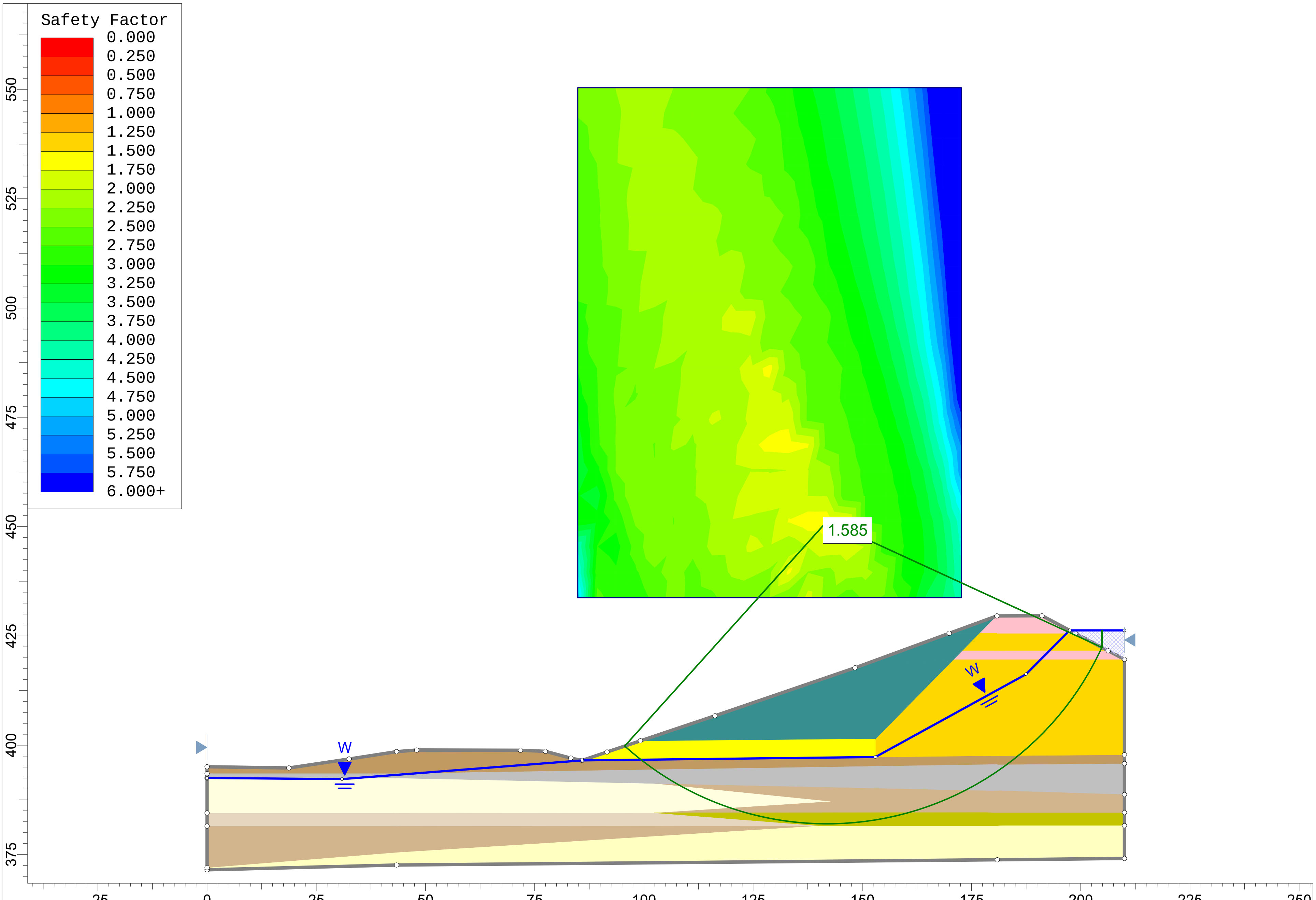
| X | Y |
|---|---|
| 102.292 | 384.543 |
| 140 | 381.6 |

## Material Boundary

| X | Y |
|---|---|
| 102.292 | 384.543 |
| 142.735 | 387.164 |
| 102.672 | 391.249 |

## Material Boundary

| X | Y |
|---|---|
| 176.879 | 425.6 |
| 180.9 | 425.6 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-1 Liquefaction Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/5/2016, 2:31:54 PM | | File Name RH-1 Seis Liq.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 391.358 |

| | |
|---|---|
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 219.309 | 426.28 |
| 230 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |

| | |
|---|---|
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
|---|---|
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
|---|---|
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
|---|---|
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
|---|---|
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
|---|---|
| 181.19 | 407.768 |

| | |
|---|---|
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

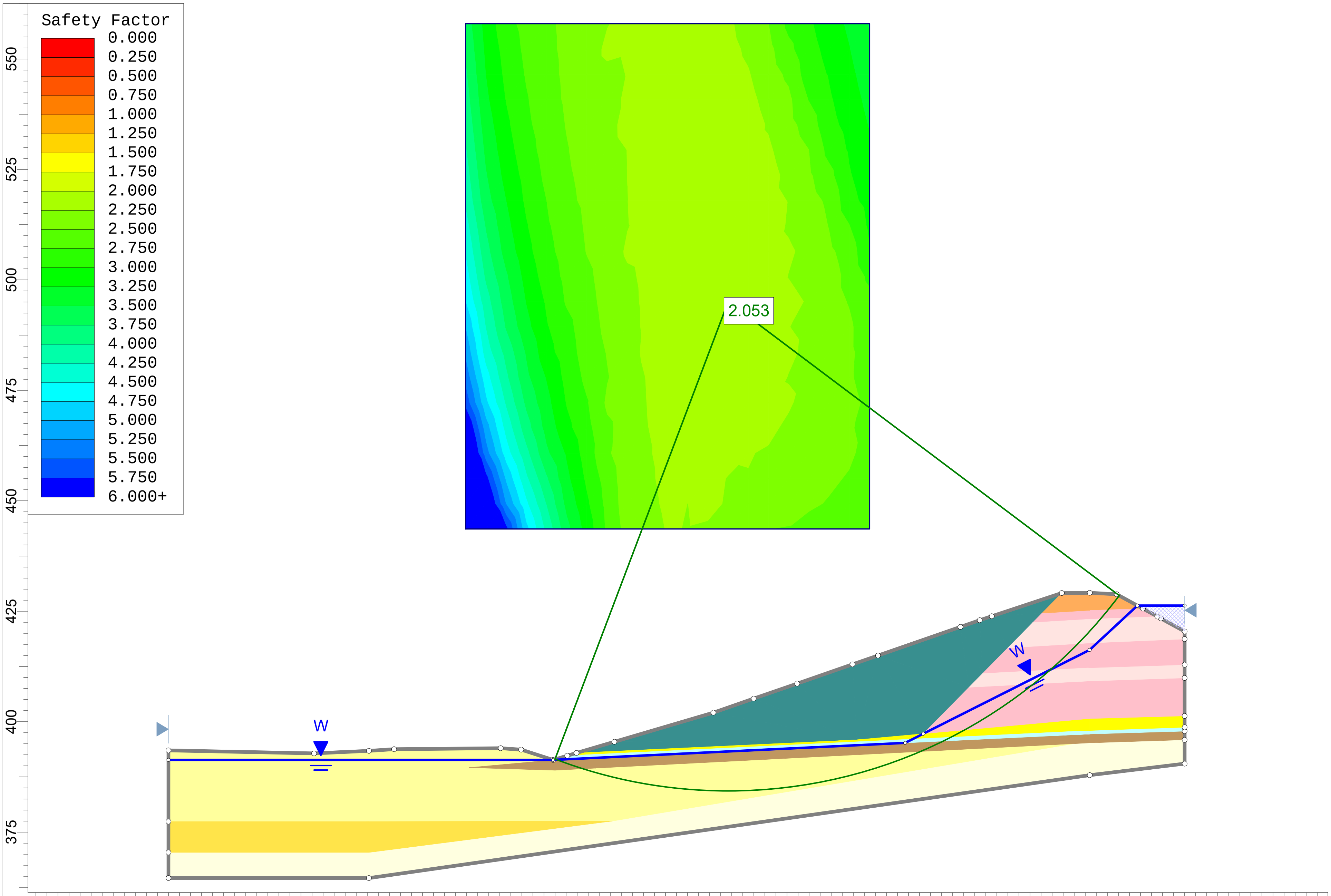
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




SLIDEINTERPRET 6.039

| | |
|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment |
| Analysis Description | Cross Section RH-2 Maximum Storage Pool Loading Condition |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 9/5/2016, 3:14:15 PM |
| File Name | RH-2.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 0 | 391.358 |

| | |
|---|---|
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 216.878 | 427.61 |
| 230 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |

| | |
|---|---|
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
| --- | --- |
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
| --- | --- |
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
| --- | --- |
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
| --- | --- |
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
| --- | --- |
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
| --- | --- |
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
| --- | --- |
| 181.19 | 407.768 |

| | |
|---|---|
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

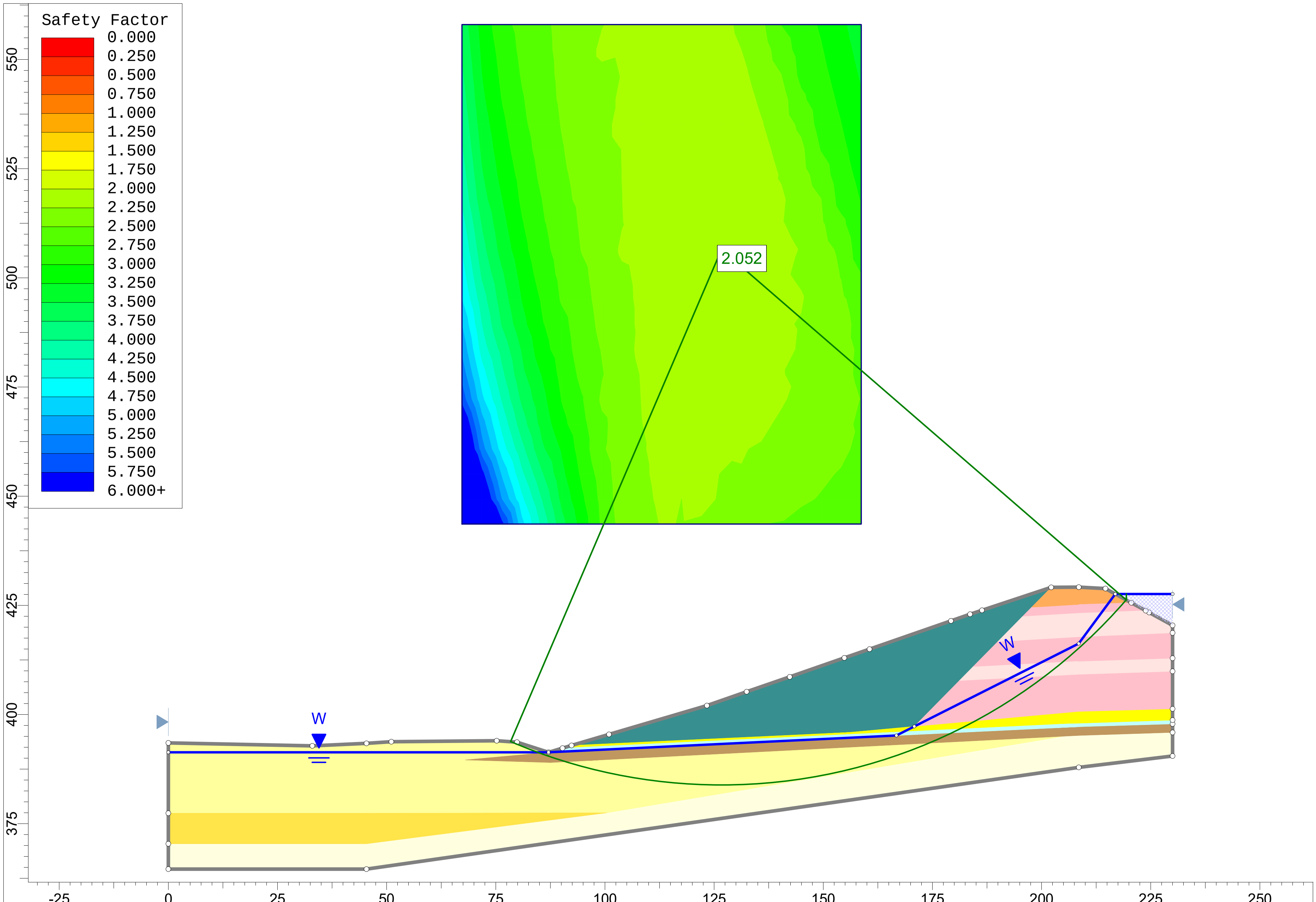
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | *Project* BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | *Analysis Description* Cross Section RH-2 Maximum Surcharge Pool Loading Condition | | |
| | *Drawn By* | *Scale* 1:360 | *Company* Associated Engineers, Inc. |
| | *Date* 9/5/2016, 3:14:15 PM | | *File Name* RH-2 Surcharge.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-2 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

- Bishop simplified
- Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay (CL) | Clayey Sand (SC) | Lean Clay (CL) | Granular Fill | Silty Sand (SC) | Lean Clay (CL) (Dam) | Lean clay With Sand (Dam) | Sandy Lean Clay (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 125.5 | 129.7 | 132 | 130 | 125.8 | 133.5 | 134.6 |
| Cohesion [psf] | 120 | 0 | 14.4 | 0 | 0 | 220 | 260 | 14.4 |
| Friction Angle [deg] | 32.3 | 33.7 | 28.7 | 31 | 33 | 30.4 | 30.6 | 33.3 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Outslope Material | Sandy Lean Clay 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 128 | 125.8 |
| Cohesion [psf] | 200 | 80 |
| Friction Angle [deg] | 30 | 29.6 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## List Of Coordinates

## Water Table

| X | Y |
|---|---|
| 0 | 391.358 |
| 87.066 | 391.358 |
| 166.755 | 395.192 |
| 170.864 | 397.272 |
| 208.5 | 416.24 |
| 219.309 | 426.28 |
| 230 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 6.548e-013 | 364.6 |
| 45.37 | 364.6 |
| 208.52 | 387.9 |
| 230 | 390.5 |
| 230 | 395.894 |
| 230 | 397.852 |
| 230 | 398.726 |
| 230 | 401.3 |
| 230 | 409.9 |
| 230 | 412.9 |
| 230 | 418.69 |
| 230 | 420.43 |
| 224.631 | 423.368 |
| 223.845 | 423.798 |
| 220.564 | 425.593 |
| 214.627 | 428.842 |
| 208.516 | 429.175 |
| 202.208 | 429.134 |
| 186.355 | 423.878 |
| 183.639 | 422.977 |
| 179.243 | 421.45 |
| 160.601 | 414.973 |
| 154.822 | 412.965 |
| 142.317 | 408.632 |
| 132.449 | 405.213 |
| 123.342 | 402.058 |
| 100.934 | 395.448 |
| 92.3437 | 392.915 |
| 90.2895 | 392.309 |
| 87.066 | 391.358 |
| 79.843 | 393.667 |

| | |
|---|---|
| 75.206 | 394.003 |
| 51.068 | 393.78 |
| 45.366 | 393.402 |
| 32.987 | 392.813 |
| 0 | 393.493 |
| 0 | 377.4 |
| 0 | 370.4 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 370.4 |
| 45.4 | 370.4 |
| 100.5 | 377.5 |
| 45.4 | 377.4 |
| 0 | 377.4 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 68 | 389.6 |
| 87.5 | 389 |
| 96.6043 | 389.467 |
| 205.063 | 395.024 |
| 208.5 | 395.2 |
| 230 | 395.894 |

## Material Boundary

| X | Y |
|---|---|
| 87.066 | 391.358 |
| 208.5 | 397.2 |
| 230 | 397.852 |

## Material Boundary

| X | Y |
|---|---|
| 90.2895 | 392.309 |
| 208.5 | 398 |
| 230 | 398.726 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 208.5 | 425.2 |
| 220.564 | 425.593 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 423.2 |
| 223.845 | 423.798 |

## Material Boundary

| X | Y |
|---|---|
| 208.5 | 400.7 |
| 230 | 401.3 |

## Material Boundary

| X | Y |
|---|---|
| 92.3437 | 392.915 |
| 155.8 | 395.9 |
| 170.864 | 397.272 |
| 208.5 | 400.7 |

## Material Boundary

| X | Y |
|---|---|
| 170.864 | 397.272 |
| 181.19 | 407.768 |
| 184.264 | 410.894 |
| 189.983 | 416.707 |
| 195.612 | 422.429 |
| 197.704 | 424.555 |
| 202.208 | 429.134 |

## Material Boundary

| X | Y |
|---|---|
| 197.704 | 424.555 |
| 208.5 | 425.2 |

## Material Boundary

| X | Y |
|---|---|
| 195.612 | 422.429 |
| 208.5 | 423.2 |

## Material Boundary

| X | Y |
|---|---|
| 181.19 | 407.768 |
| 208.5 | 409.2 |
| 230 | 409.9 |

## Material Boundary

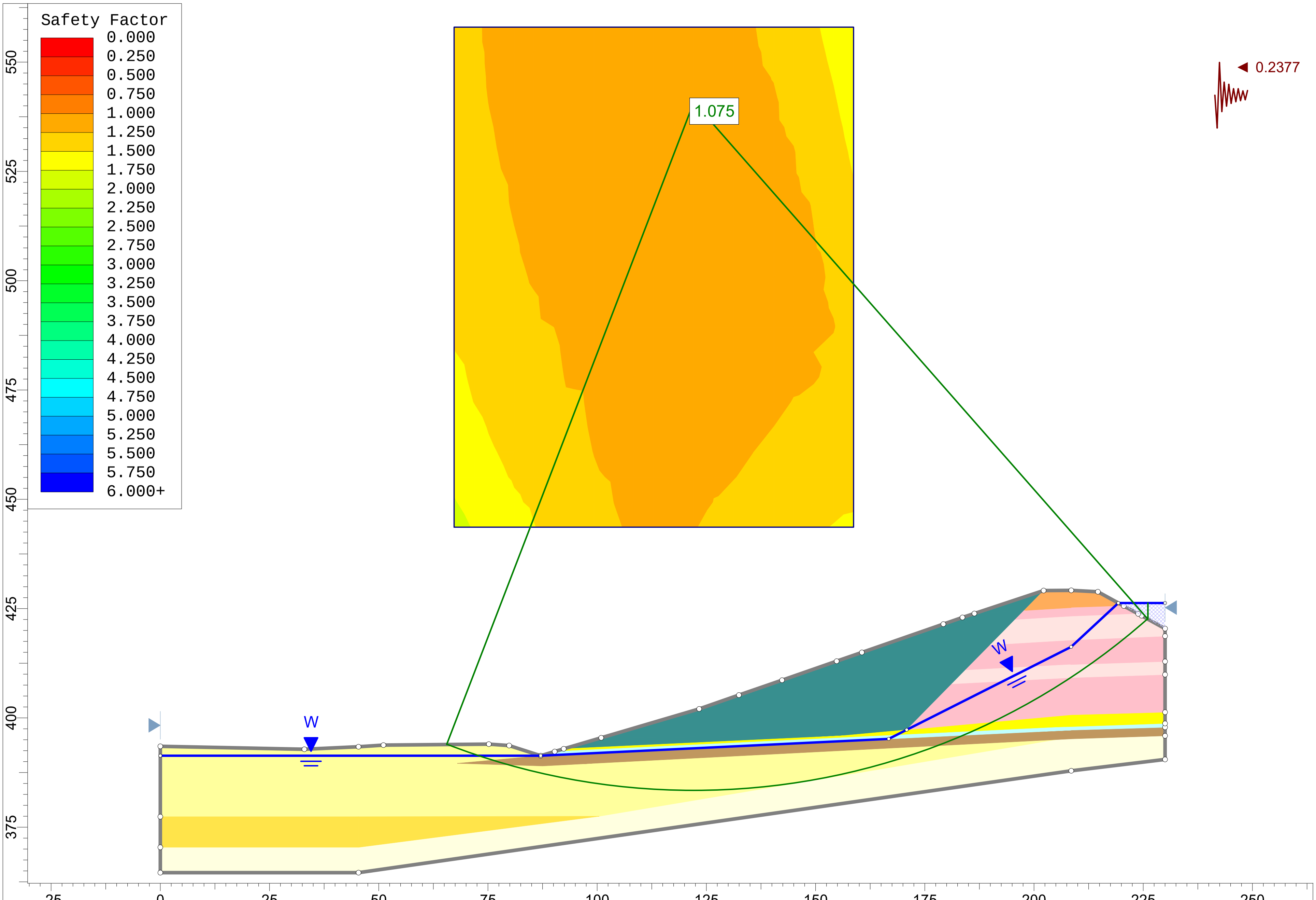
| X | Y |
|---|---|
| 184.264 | 410.894 |
| 208.5 | 412.2 |
| 230 | 412.9 |

## Material Boundary

| X | Y |
|---|---|
| 189.983 | 416.707 |
| 208.5 | 417.8 |
| 230 | 418.69 |

## Material Boundary

| X | Y |
|---|---|
| 100.5 | 377.5 |
| 205.063 | 395.024 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-2 Seismic Loading Condition | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date 9/5/2016, 3:14:15 PM | | File Name | RH-2 Seis.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-3
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Maximum Storage Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 276.537 | 426.277 |
| 285 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |

| | |
|---|---|
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |

| | |
|---|---|
| 285 | 393.6 |

## Material Boundary

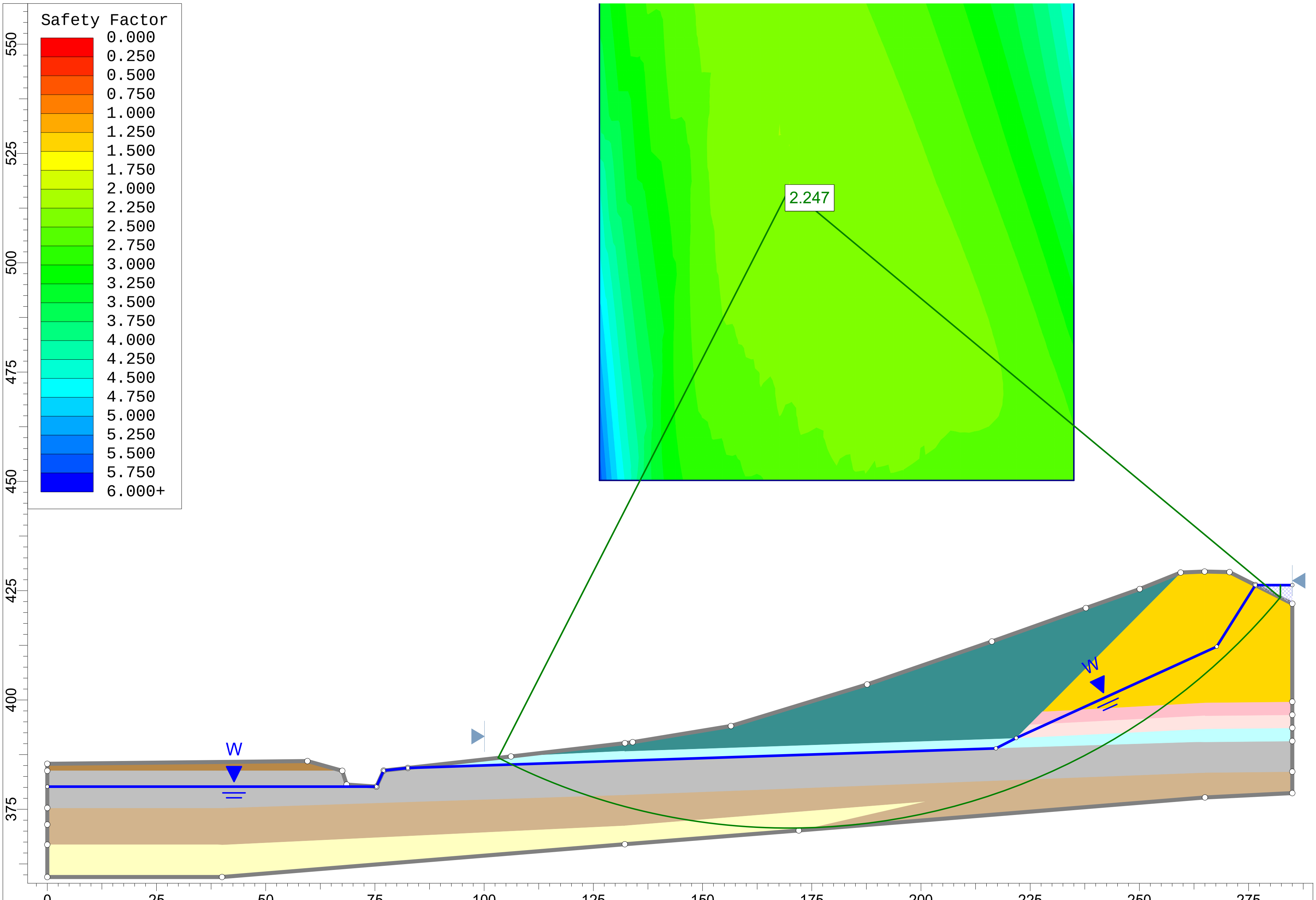
| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

## Material Boundary

| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-3 Maximum Storage Pool Loading Conditon | | |
| Drawn By | | Scale 1:360 | Company: Associated Engineers, Inc. |
| Date | 8/29/2016, 2:56:23 PM | | File Name: RH-3.slim |

SLIDEINTERPRET 6.039

# *Slide Analysis Information*

# *BREC Reid/HMPL Station CCR Surface Impoundment*

## *Project Summary*

File Name: RH-3 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impooundment
Analysis: Cross Section RH-3 Maximum Surcharge Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## *General Settings*

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## *Analysis Options*

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## *Groundwater Analysis*

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## *Random Numbers*

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 273.872 | 427.613 |
| 285 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |

| | |
|---|---|
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |

| | |
|---|---|
| 285 | 393.6 |

## Material Boundary

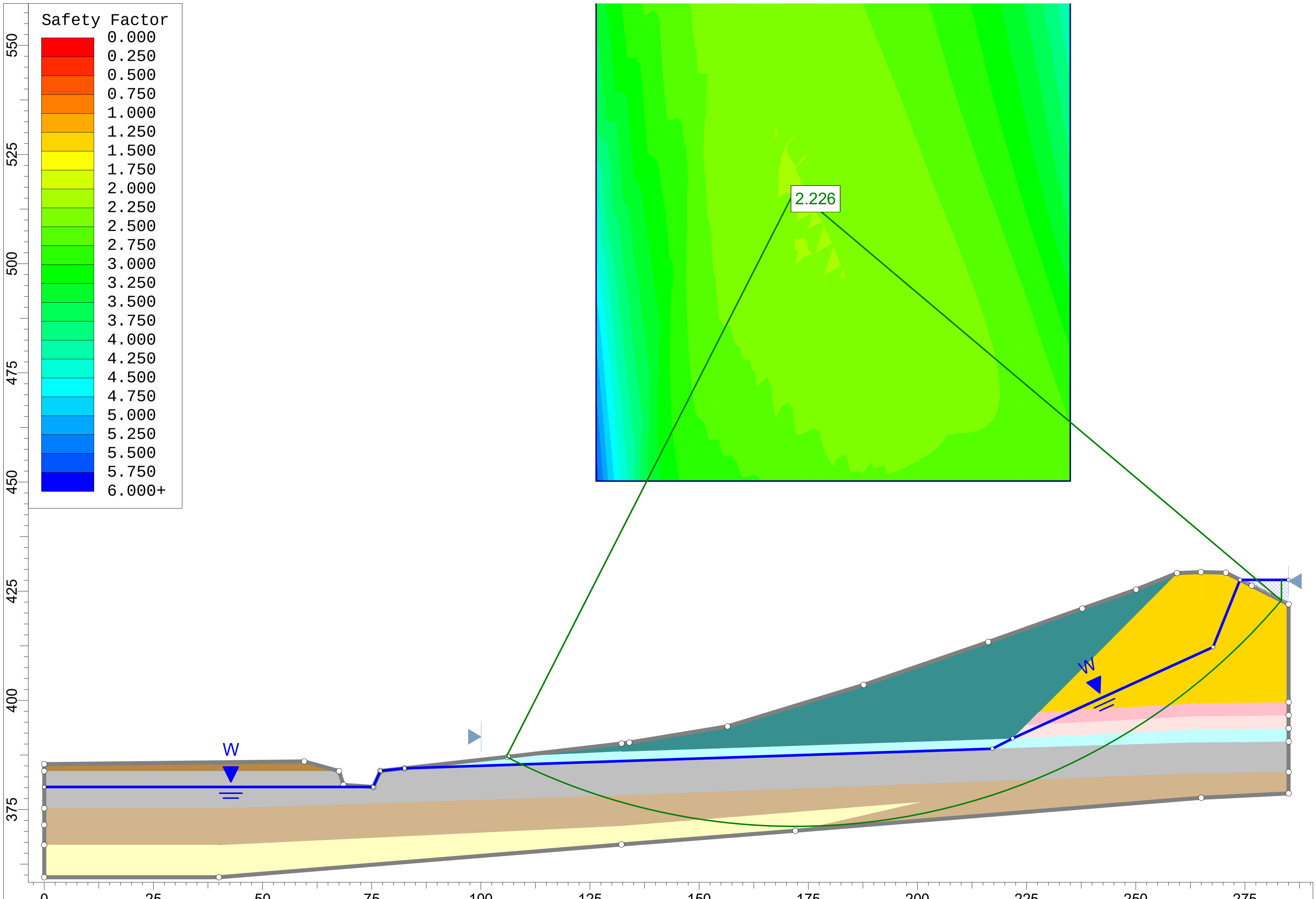
| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

## Material Boundary

| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |




| | | | |
|---|---|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-3 Maximum Surcharge Pool Loading Conditon | | |
| Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| Date | 8/29/2016, 2:56:23 PM | File Name | RH-3 Surcharge.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-3 Seis
Slide Modeler Version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Seismic Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular

Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Sandy Lean Clay | Lean Clay | Silty Clay (CL-ML) | Granular Fill and Lean Clay | Outslope Material (Dam) | Lean Clay with Sand (CL) (Dam) | Sandy Lean Clay (CL)(Dike) | Lean Clay (CL) (Dam) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 132.7 | 134.1 | 125.8 | 132 | 128 | 133.5 | 134.6 | 125.8 |
| Cohesion [psf] | 120 | 72 | 200 | 0 | 200 | 260 | 14.4 | 220 |
| Friction Angle [deg] | 32.3 | 30.4 | 33.7 | 31 | 30 | 30.6 | 33.3 | 30.4 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Property | Lean Clay (CL) 2 |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 129.7 |
| Cohesion [psf] | 14.4 |
| Friction Angle [deg] | 28.7 |
| Water Surface | Water Table |
| Hu Value | 1 |

## Global Minimums

### Method: bishop simplified

FS: 1.146920
Center: 169.832, 521.855
Radius: 150.630
Left Slip Surface Endpoint: 103.229, 386.750
Right Slip Surface Endpoint: 283.359, 422.856
Left Slope Intercept: 103.229 386.750
Right Slope Intercept: 283.359 426.279
Resisting Moment=4.1388e+007 lb-ft
Driving Moment=3.60862e+007 lb-ft

Total Slice Area=4300.6 ft2

## *Valid / Invalid Surfaces*

### Method: bishop simplified

Number of Valid Surfaces: 27798
Number of Invalid Surfaces: 813

#### Error Codes:

Error Code -103 reported for 812 surfaces
Error Code -108 reported for 1 surface

#### Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

## *Slice Data*

**Global Minimum Query (bishop simplified) - Safety Factor**: 1.14692

| Slice Number | Width [ft] | Weight [lbs] | Base Material | Base Cohesion [psf] | Base Friction Angle [degrees] | Shear Stress [psf] | Shear Strength [psf] | Base Normal Stress [psf] | Pore Pressure [psf] | Effective Normal Stress [psf] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.9517 | 339.413 | Granular Fill and Lean Clay | 0 | 31 | 80.4502 | 92.27 | 153.563 | 0 | 153.563 |
| 2 | 9.38923 | 5181.12 | Silty Clay (CL-ML) | 200 | 33.7 | 558.746 | 640.837 | 789.603 | 128.596 | 661.007 |
| 3 | 9.38923 | 10797.8 | Silty Clay (CL-ML) | 200 | 33.7 | 784.082 | 899.279 | 1423.39 | 374.861 | 1048.53 |
| 4 | 8.05892 | 13218.6 | Lean Clay | 72 | 30.4 | 715.465 | 820.581 | 1841.85 | 565.927 | 1275.92 |
| 5 | 8.05892 | 16561.5 | Lean Clay | 72 | 30.4 | 847.784 | 972.34 | 2244.15 | 709.561 | 1534.59 |
| 6 | 8.05892 | 19639.6 | Lean Clay | 72 | 30.4 | 970.425 | 1113 | 2598.53 | 824.191 | 1774.34 |
| 7 | 7.11739 | 19518.9 | Sandy Lean Clay | 120 | 32.3 | 1191.41 | 1366.45 | 2878.89 | 907.191 | 1971.7 |
| 8 | 7.11739 | 21628 | Sandy Lean Clay | 120 | 32.3 | 1296.89 | 1487.43 | 3125.23 | 962.17 | 2163.06 |
| 9 | 7.11739 | 23899.4 | Sandy Lean Clay | 120 | 32.3 | 1421.59 | 1630.45 | 3385.29 | 995.992 | 2389.3 |
| 10 | 7.11739 | 25852.9 | Sandy Lean Clay | 120 | 32.3 | 1527.15 | 1751.52 | 3589.6 | 1008.79 | 2580.81 |
| 11 | 7.97951 | 30912.3 | Lean Clay | 72 | 30.4 | 1474.5 | 1691.13 | 3758.42 | 998.688 | 2759.74 |
| 12 | 7.97951 | 32613.8 | Lean Clay | 72 | 30.4 | 1555.8 | 1784.38 | 3881.46 | 962.77 | 2918.69 |
| 13 | 7.97951 | 34074 | Lean Clay | 72 | 30.4 | 1630.67 | 1870.25 | 3964.78 | 899.728 | 3065.05 |
| 14 | 7.97951 | 35060.3 | Lean Clay | 72 | 30.4 | 1686.13 | 1933.86 | 3982.32 | 808.85 | 3173.47 |
| 15 | 7.97951 | 35547.6 | Lean Clay | 72 | 30.4 | 1722.09 | 1975.1 | 3932.9 | 689.137 | 3243.76 |
| 16 | 7.97951 | 35611.6 | Lean Clay | 72 | 30.4 | 1688.19 | 1936.22 | 3846.3 | 668.812 | 3177.49 |
| 17 | 8.30823 | 36828.4 | Silty Clay (CL-ML) | 200 | 33.7 | 1874.3 | 2149.67 | 3621.62 | 698.224 | 2923.4 |
| 18 | 8.30823 | 36298.1 | Silty Clay (CL-ML) | 200 | 33.7 | 1786.34 | 2048.79 | 3462.85 | 690.709 | 2772.14 |
| 19 | 4.95864 | 21118.6 | Granular Fill and Lean Clay | 0 | 31 | 1451.21 | 1664.42 | 3429.39 | 659.333 | 2770.06 |
| 20 | 5.12784 | 21134.1 | Lean Clay with Sand (CL) (Dam) | 260 | 30.6 | 1539.33 | 1765.49 | 3159.94 | 614.305 | 2545.64 |
| 21 | 4.73463 | 18862 | Lean Clay (CL) (Dam) | 220 | 30.4 | 1443.82 | 1655.95 | 3001.55 | 554.028 | 2447.52 |
| 22 | 6.60985 | 24515 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 1310.13 | 1502.61 | 2725.55 | 459.958 | 2265.59 |
| 23 | 6.60985 | 20127.3 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 1061.56 | 1217.53 | 2150.92 | 319.337 | 1831.59 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 6.60985 | 13526.4 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 565.291 | 648.343 | 1510.28 | 545.202 | 965.081 |
| 25 | 6.60985 | 5362.88 | Sandy Lean Clay (CL)(Dike) | 14.4 | 33.3 | 141.118 | 161.851 | 659.69 | 435.217 | 224.473 |

## *Interslice Data*

**Global Minimum Query (bishop simplified) - Safety Factor**: 1.14692

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 103.229 | 386.75 | 0 | 0 | 0 |
| 2 | 106.18 | 385.335 | 374.121 | 0 | 0 |
| 3 | 115.57 | 381.338 | 7543.64 | 0 | 0 |
| 4 | 124.959 | 378.064 | 16998.2 | 0 | 0 |
| 5 | 133.018 | 375.793 | 23804.5 | 0 | 0 |
| 6 | 141.077 | 373.995 | 30733.8 | 0 | 0 |
| 7 | 149.136 | 372.654 | 37371.2 | 0 | 0 |
| 8 | 156.253 | 371.839 | 43557.5 | 0 | 0 |
| 9 | 163.37 | 371.364 | 49129.3 | 0 | 0 |
| 10 | 170.488 | 371.227 | 54029.8 | 0 | 0 |
| 11 | 177.605 | 371.426 | 58037.4 | 0 | 0 |
| 12 | 185.585 | 372.051 | 60103.9 | 0 | 0 |
| 13 | 193.564 | 373.107 | 60668.5 | 0 | 0 |
| 14 | 201.544 | 374.601 | 59653.7 | 0 | 0 |
| 15 | 209.523 | 376.549 | 57017.3 | 0 | 0 |
| 16 | 217.503 | 378.968 | 52794.3 | 0 | 0 |
| 17 | 225.482 | 381.882 | 46588 | 0 | 0 |
| 18 | 233.79 | 385.478 | 40381 | 0 | 0 |
| 19 | 242.099 | 389.693 | 31998 | 0 | 0 |
| 20 | 247.057 | 392.528 | 24451.6 | 0 | 0 |
| 21 | 252.185 | 395.731 | 17198.2 | 0 | 0 |
| 22 | 256.92 | 398.953 | 9880.41 | 0 | 0 |
| 23 | 263.53 | 403.914 | -811.059 | 0 | 0 |
| 24 | 270.139 | 409.482 | -10555.3 | 0 | 0 |
| 25 | 276.749 | 415.751 | -19503.3 | 0 | 0 |
| 26 | 283.359 | 422.856 | 365.715 | 0 | 0 |

## *List Of Coordinates*

### Water Table

| X | Y |
|---|---|
| -1.11022e-016 | 380.175 |
| 75.344 | 380.175 |
| 77.002 | 383.846 |
| 82.5127 | 384.456 |
| 217.136 | 388.922 |
| 221.8 | 391.3 |
| 267.7 | 412.21 |
| 276.537 | 426.277 |

| | |
|---|---|
| 285 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 276.537 | 426.277 |
| 270.621 | 429.244 |
| 264.923 | 429.374 |
| 259.45 | 429.143 |
| 250.06 | 425.382 |
| 237.754 | 421.038 |
| 216.209 | 413.372 |
| 187.674 | 403.549 |
| 156.481 | 394.047 |
| 133.994 | 390.347 |
| 132.225 | 390.139 |
| 106.149 | 387.073 |
| 82.5127 | 384.456 |
| 77.002 | 383.846 |
| 75.344 | 380.175 |
| 68.53 | 380.645 |
| 67.51 | 383.799 |
| 59.536 | 386.037 |
| 0 | 385.411 |
| 0 | 383.8 |
| 1.38778e-017 | 375.3 |
| 0 | 371.5 |
| 0 | 366.9 |
| 0 | 359.5 |
| 40 | 359.5 |
| 132.2 | 367 |
| 172.029 | 370.145 |
| 265 | 377.7 |
| 285 | 378.7 |
| 285 | 383.6 |
| 285 | 390.6 |
| 285 | 393.6 |
| 285 | 396.6 |
| 285 | 399.6 |
| 285 | 422.033 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 366.9 |
| 40 | 366.9 |
| 132.2 | 371.3 |
| 201 | 376.8 |
| 172.029 | 370.145 |

## Material Boundary

| X | Y |
|---|---|
| 1.38778e-017 | 375.3 |
| 40 | 375.3 |
| 132.2 | 378.3 |
| 265 | 383.4 |
| 285 | 383.6 |

## Material Boundary

| X | Y |
|---|---|
| 82.5127 | 384.456 |
| 132.2 | 386.3 |
| 265 | 390.4 |
| 285 | 390.6 |

## Material Boundary

| X | Y |
|---|---|
| 0 | 383.8 |
| 40 | 383.8 |
| 67.51 | 383.799 |

## Material Boundary

| X | Y |
|---|---|
| 106.149 | 387.073 |
| 132.2 | 388.3 |
| 221.8 | 391.3 |
| 265 | 393.4 |
| 285 | 393.6 |

## Material Boundary

| X | Y |
|---|---|
| 221.8 | 391.3 |
| 224.786 | 394.301 |
| 227.81 | 397.341 |
| 259.45 | 429.143 |

## Material Boundary

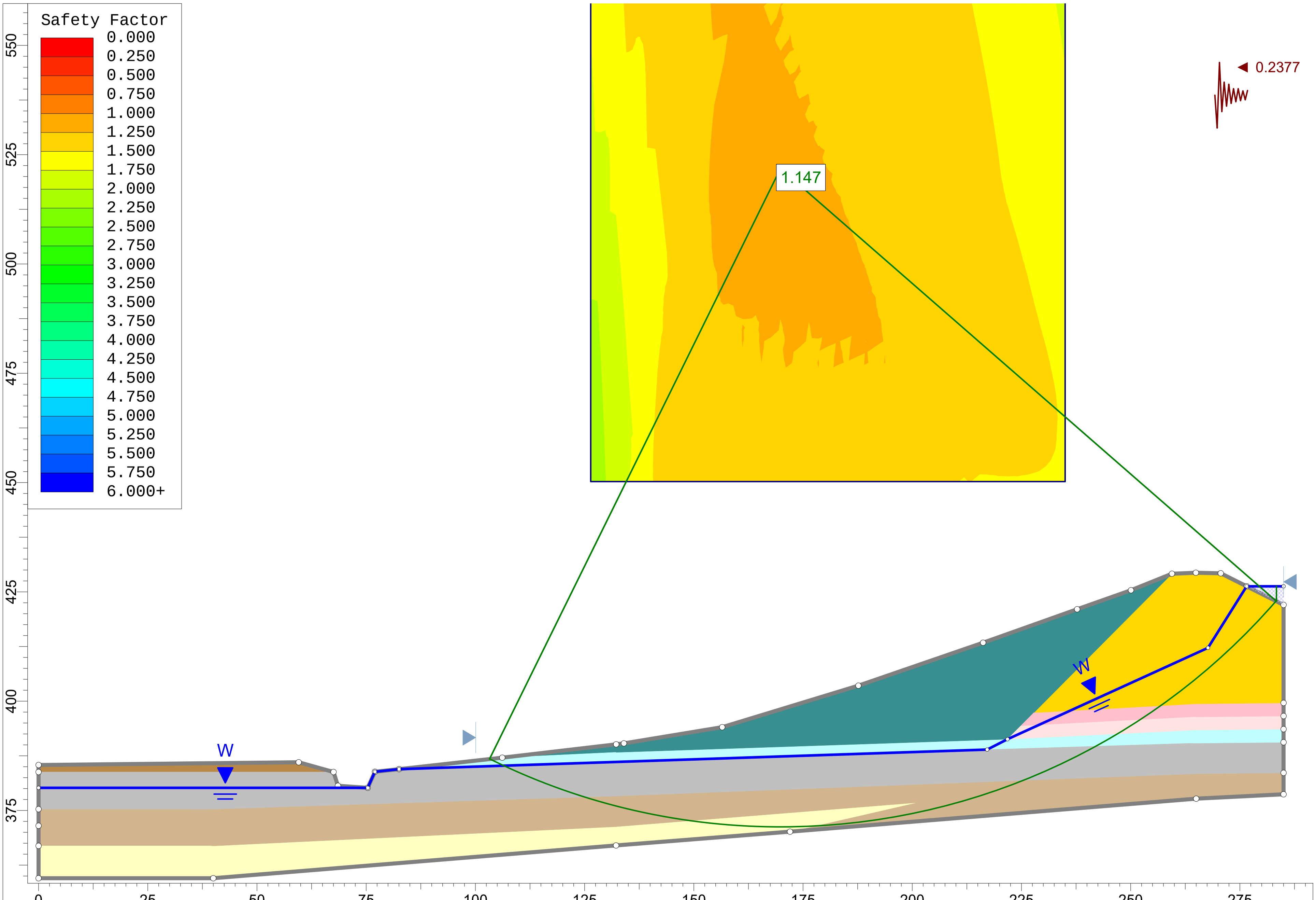
| X | Y |
|---|---|
| 224.786 | 394.301 |
| 265 | 396.4 |
| 285 | 396.6 |

## Material Boundary

| X | Y |
|---|---|

| | |
|---|---|
| 227.81 | 397.341 |
| 265 | 399.4 |
| 285 | 399.6 |

| | | | |
|---|---|---|---|
| rocscience | Project | BREC Reid/HMPL Station CCR Surface Impoundment | |
| | Analysis Description | Cross Section RH-3 Seismic Loading Conditon | |
| | Drawn By | Scale | Company: Associated Engineers, Inc. |
| SLIDEINTERPRET 6.039 | Date: 8/29/2016, 2:56:23 PM | | File Name: RH-3 Seis.slim |




| | |
|---|---|
| Project | BREC Reid/HMPL Station CCR Surface Impoundment |
| Analysis Description | Cross Section RH-3 Seismic Loading Conditon |
| Drawn By | |
| Scale | 1:360 |
| Company | Associated Engineers, Inc. |
| Date | 8/29/2016, 2:56:23 PM |
| File Name | RH-3 Seis.slim |

SLIDEINTERPRET 6.039

# *Slide Analysis Information*

# *BREC Reid HMPL Station CCR Surface Impoundment*

## *Project Summary*

File Name: RH-4
Last saved with Slide version: 6.039
Project Title: BREC Reid HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## *General Settings*

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## *Analysis Options*

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## *Groundwater Analysis*

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## *Random Numbers*

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Lean Clay (CL) | Silty Clay (CL-ML) | Lean Clay With Sand (CL) (Dam) | Lean Clay (CL) (Dam) | Silty Sand (SM) | Outslope Material (Dam) | Lean Clay (CL) (1) | Lean Clay (CL)/Clayey Sand (SC) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 128 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 200.877 | 426.28 |
| 215 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |
| 189.8 | 409.4 |

| | |
|---|---|
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
| --- | --- |
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

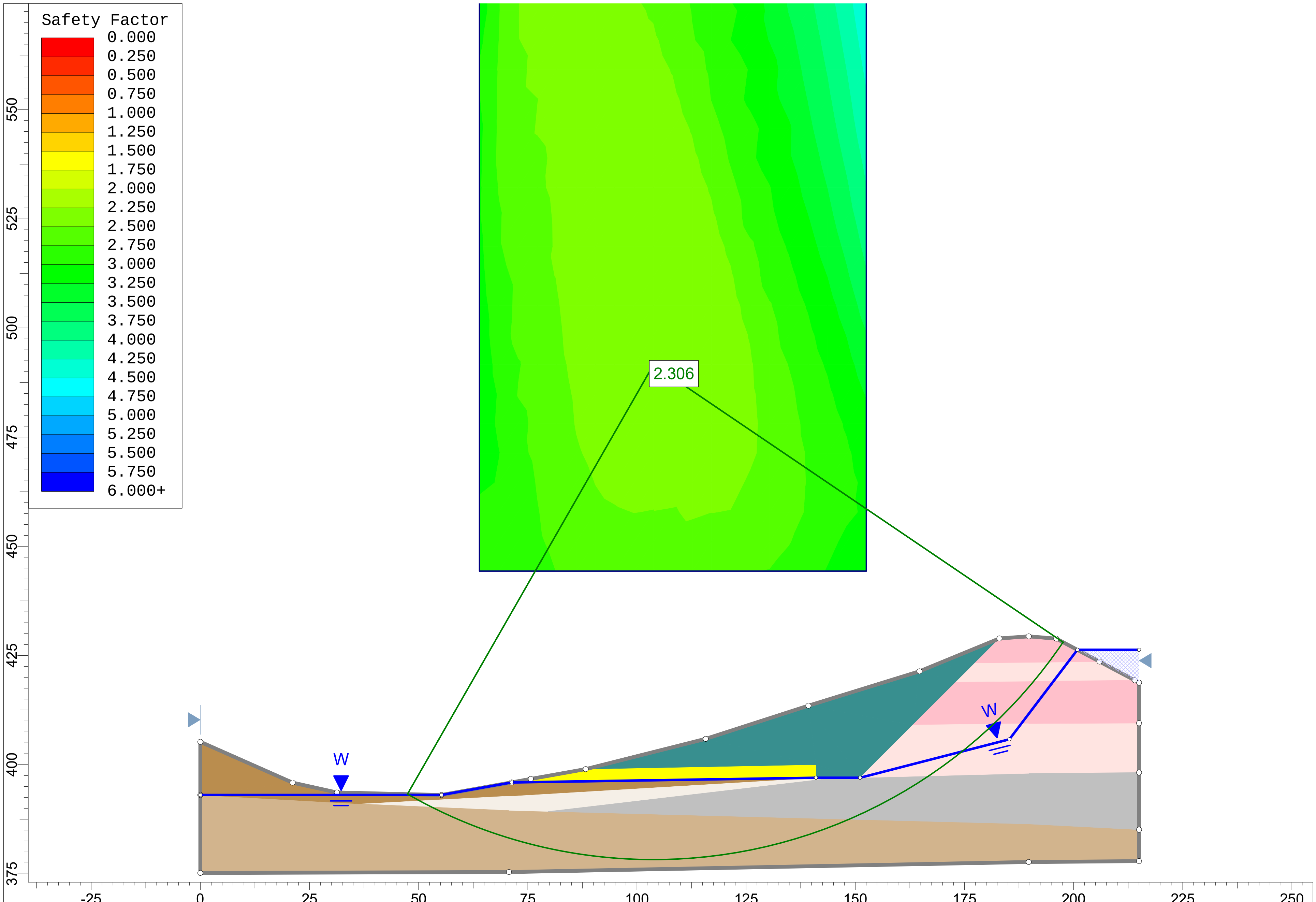
| X | Y |
| --- | --- |
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
| --- | --- |
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
| --- | --- |
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | | | |
|---|---|---|---|
| Project | BREC Reid HMPL Station CCR Surface Impoundment | | |
| Analysis Description | Cross Section RH-4 Maximum Storage Pool Loading Condition | | |
| Drawn By | | Scale 1:360 | Company Associated Engineers, Inc. |
| Date | 9/4/2016, 12:09:41 PM | | File Name RH-4.slim |

SLIDEINTERPRET 6.039

# Slide Analysis Information
# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-4 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Material Properties

| Property | Lean Clay (CL) | Silty Clay (CL-ML) | Lean Clay With Sand (CL) (Dam) | Lean Clay (CL) (Dam) | Silty Sand (SM) | Outslope Material (Dam) | Lean Clay (CL) (1) | Lean Clay (CL)/Clayey Sand (SC) |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 128 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 198.372 | 427.61 |
| 215 | 427.61 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |
| 189.8 | 409.4 |

| | |
|---|---|
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
|---|---|
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

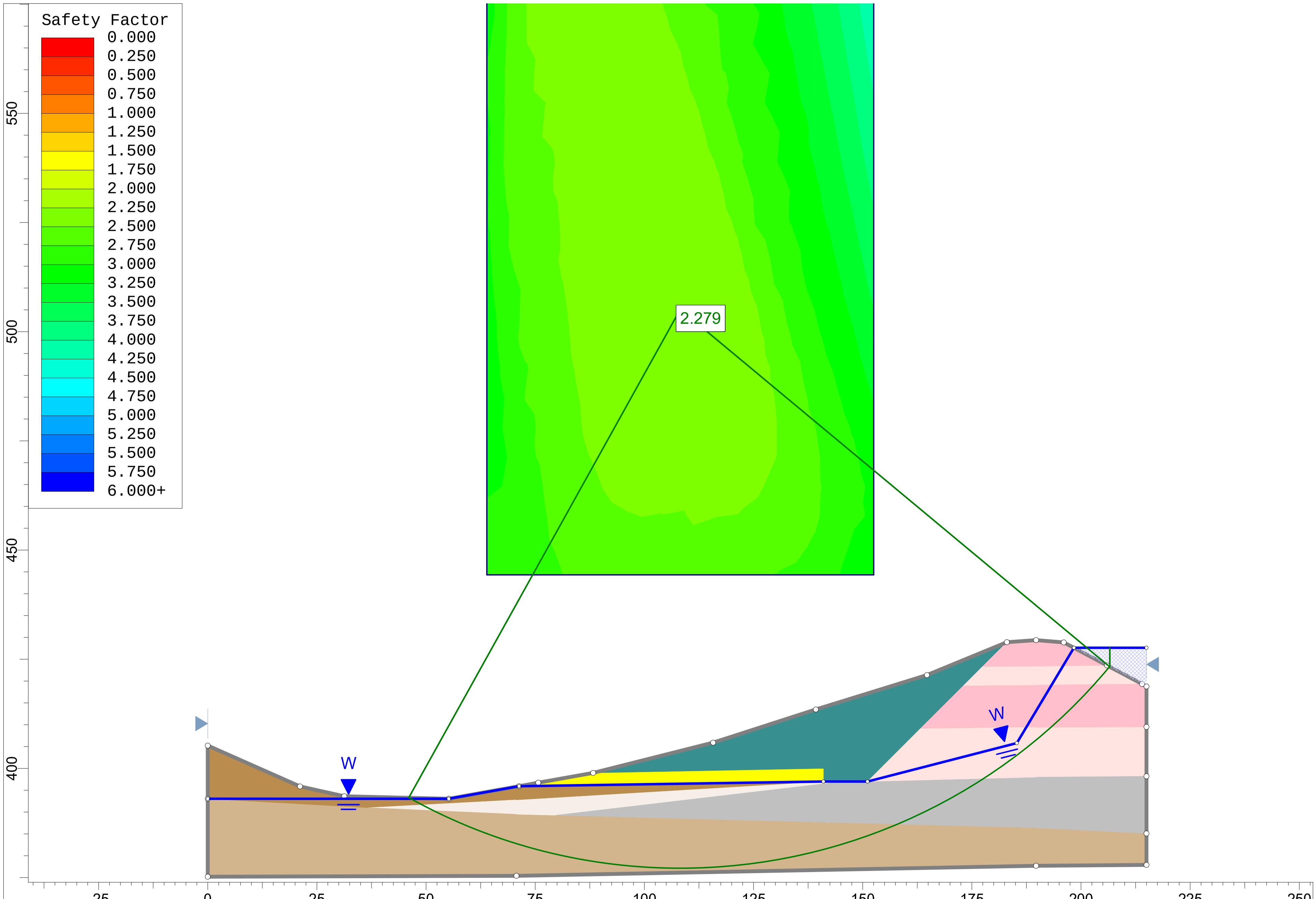
| X | Y |
|---|---|
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
|---|---|
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | | | | |
|---|---|---|---|---|
| SLIDEINTERPRET 6.039 | Project | BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | Analysis Description | Cross Section RH-4 Maximum Surcharge Pool Loading Condition | | |
| | Drawn By | Scale 1:360 | Company | Associated Engineers, Inc. |
| | Date | 9/4/2016, 12:09:41 PM | File Name | RH-4 Surcharge.slim |

# Slide Analysis Information

# BREC Reid/HMPL Station CCR Surface Impoundment

## Project Summary

File Name: RH-4 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

## General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

## Analysis Options

### Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

## Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

## Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

## Loading

Seismic Load Coefficient (Horizontal): 0.2377

## Material Properties

| Property | Lean clay | Silty clay | Lean Clay with sand (dike) | Lean clay (dike) | Silty sand (SM) | Sandy wedge | Lean clay OG | Lean clay with sand |
|---|---|---|---|---|---|---|---|---|
| Color | | | | | | | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 134.1 | 125.8 | 133.5 | 125.8 | 130 | 130 | 129.7 | 125.8 |
| Cohesion [psf] | 72 | 200 | 260 | 220 | 0 | 200 | 14.4 | 80 |
| Friction Angle [deg] | 30.4 | 33.7 | 30.6 | 30.4 | 33 | 30 | 28.7 | 29.6 |
| Water Surface | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table | Water Table |
| Hu Value | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## List Of Coordinates

### Water Table

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 55.19 | 393.033 |
| 71.2842 | 395.917 |
| 141 | 397 |
| 151.1 | 397 |
| 185.3 | 405.78 |
| 200.877 | 426.28 |
| 215 | 426.28 |

## External Boundary

| X | Y |
|---|---|
| 215 | 418.777 |
| 213.982 | 419.318 |
| 205.956 | 423.582 |
| 196.055 | 428.841 |
| 189.723 | 429.373 |
| 183.027 | 428.888 |
| 164.711 | 421.366 |
| 139.268 | 413.482 |
| 115.733 | 405.895 |
| 88.257 | 398.958 |
| 75.6909 | 396.706 |
| 71.2842 | 395.917 |
| 55.19 | 393.033 |
| 31.267 | 393.626 |
| 21.125 | 395.865 |
| 0 | 405.212 |
| 2.77556e-017 | 393.033 |
| 0 | 375.2 |
| 70.69 | 375.4 |
| 189.72 | 377.7 |
| 215 | 377.9 |
| 215 | 385.1 |
| 215 | 398.2 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 400 |
| 141 | 397 |
| 145.463 | 397 |
| 151.1 | 397 |
| 163.168 | 409.053 |
| 173.086 | 418.959 |
| 177.455 | 423.323 |
| 183.027 | 428.888 |

## Material Boundary

| X | Y |
|---|---|
| 163.168 | 409.053 |

| | |
|---|---|
| 189.8 | 409.4 |
| 215 | 409.5 |

## Material Boundary

| X | Y |
|---|---|
| 151.1 | 397 |
| 189.8 | 398 |
| 215 | 398.2 |

## Material Boundary

| X | Y |
|---|---|
| 141 | 397 |
| 70.7 | 392.8 |
| 36.8 | 391 |
| 70.7 | 389.5 |
| 79.6711 | 389.266 |
| 189.8 | 386.4 |
| 215 | 385.1 |

## Material Boundary

| X | Y |
|---|---|
| 71.2842 | 395.917 |
| 141 | 397 |

## Material Boundary

| X | Y |
|---|---|
| 88.257 | 398.958 |
| 141 | 400 |

## Material Boundary

| X | Y |
|---|---|
| 173.086 | 418.959 |
| 189.8 | 419.1 |

## Material Boundary

| X | Y |
|---|---|
| 189.8 | 419.1 |
| 213.982 | 419.318 |

## Material Boundary

| X | Y |
|---|---|
| 177.455 | 423.323 |
| 189.8 | 423.4 |

## Material Boundary

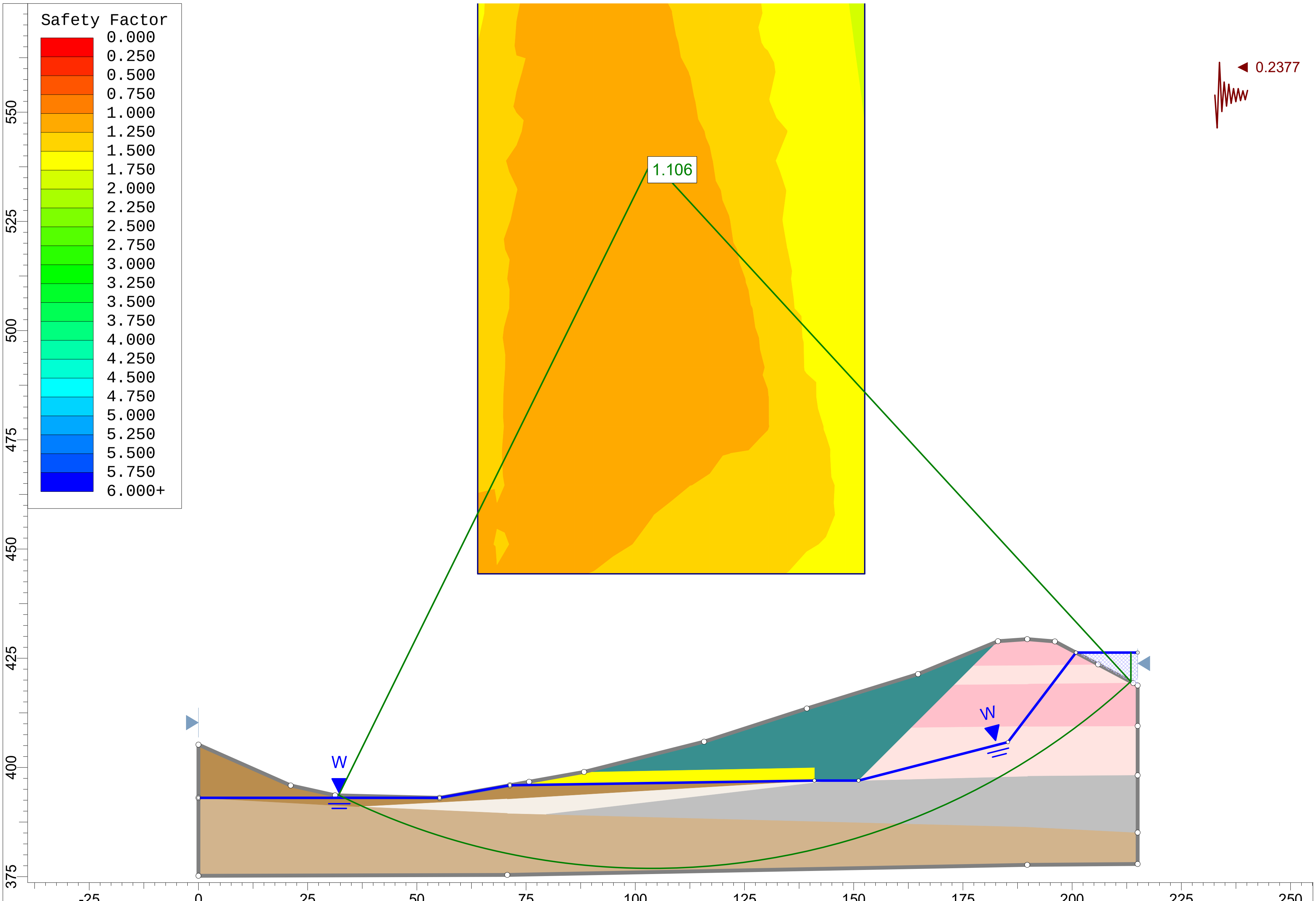
| X | Y |
|---|---|
| 189.8 | 423.4 |
| 205.956 | 423.582 |

## Material Boundary

| X | Y |
|---|---|
| 2.77556e-017 | 393.033 |
| 36.8 | 391 |

## Material Boundary

| X | Y |
|---|---|
| 79.6711 | 389.266 |
| 145.463 | 397 |




| | | | |
|---|---|---|---|
| SLIDEINTERPRET 6.039 | Project: BREC Reid/HMPL Station CCR Surface Impoundment | | |
| | Analysis Description: Cross Section RH-4 Seismic Loading Condition | | |
| | Drawn By: | Scale: 1:360 | Company: Associated Engineers, Inc. |
| | Date: 9/4/2016, 12:09:41 PM | | File Name: RH-4 Seis 2.slim |

**ATTACHMENT 13 - CLOSURE PLAN**

# Closure Plan for the Green Station CCR Surface Impoundment

## Big Rivers Electric Corporation

### Robert D. Green Generating Station

Coal Combustion Residual Rule Compliance

# Closure Plan for the Green Station CCR Surface Impoundment

Prepared for

Big Rivers Electric Corporation
Robert D. Green Generating Station
Roberts, Kentucky

Revision 2
11/24/2020

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

.

# INDEX AND CERTIFICATION

## Big Rivers Electric Corporation
## Closure Plan for the Green Station CCR Surface Impoundment

### Report Index


| Chapter Number | Chapter Title | Number of Pages |
|---|---|---|
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| 2.0 | Details of Closure | 5 |
| 3.0 | Revisions and Amendments | 1 |
| 4.0 | Record of Revisions and Updates | 1 |
| Appendix A | Site Plan | 1 |


### Certification

I hereby certify, as a Professional Engineer in the State of Kentucky, that the information in this document was assembled under my direct supervisory control. This report is not intended or represented to be suitable for reuse by Big Rivers Electric Corporation or others without specific verification or adaptation by the Engineer.

Samuel Yoder, P.E. Kentucky License #31964

Date: 11/24/2020

STATE OF KENTUCKY
SAMUEL YODER
31964
LICENSED PROFESSIONAL ENGINEER

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2.0 DETAILS OF CLOSURE....................2-1
2.1 Impoundment Description....................2-1
2.1.1 CCR Inventory and Extent....................2-1
2.2 Closure Method....................2-1
2.2.1 Final Cover System....................2-3
2.2.2 Final Cover Schedule....................2-5

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4.0 RECORD OF REVISIONS AND UPDATES....................4-1

APPENDIX A – SITE PLAN

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Figure 2-2: Typical Alternative Final Cover System.................................................................. 2-4

# LIST OF ABBREVIATIONS

| Abbreviation | Term/Phrase/Name |
|---|---|
| BREC | Big Rivers Electric Corporation |
| CCR | Coal Combustion Residuals |
| CFR | Code of Federal Regulations |
| cm/sec | centimeters per second |
| EPA | Environmental Protection Agency |
| FGD | Flue Gas Desulfurization |
| RCRA | Resource Conservation and Recovery Act |
| USACE | United State Army Corps of Engineers |
| U.S.C. | United States Code |
| WMB | Water Mass Balance |

# 1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the federal Coal Combustion Residuals (CCR) Rule to regulate the disposal of coal combustion residual materials generated at coal-fired units. The rule is administered as part of the Resource Conservation and Recovery Act (RCRA, 42 United States Code [U.S.C.] §6901 et seq.), using the Subtitle D approach.

Big Rivers Electric Corporation (BREC) is subject to the CCR Rule and as such must develop a Closure Plan per 40 Code of Federal Regulations (CFR) §257.102. This document serves as BREC's Closure Plan for the Green Station (Green) CCR Surface Impoundment (Ash Pond).

According to §257.102(b)(1), the Closure Plan must contain the following:

- A description of how the CCR unit will be closed.
  - For in-place closure: A description of the final cover system, the methods for installing the final cover system, and the methods for achieving compliance with the standards outlined in §257.102(d).
  - For closure by removal: A description of the procedures to remove the CCR and decontaminate the CCR unit as outlined in §257.102(c).
- An estimate of the maximum amount of material ever stored in the CCR unit over its active life.
- An estimate of the largest area of the CCR unit ever requiring a final cover as required by §257.102(d) at any time during the CCR unit's active life.
- A schedule for completing closure activities, including the anticipated year of closure and major milestones for permitting and construction activities.

The seal on this report certifies that this document meets the requirements of 40 CFR §257.102(b). This closure plan is in addition to, not in place of, any other applicable site permits, environmental standards, or work safety practices.

# 2.0 DETAILS OF CLOSURE

## 2.1 Impoundment Description

Green is a coal-fueled electric generating station near Robards, Kentucky. The plant consists of Unit 1 and Unit 2 which are respectively 250MW and 242MW (gross) units commercialized in 1979 and 1981 respectively. Units 1 and 2 burn a blend of bituminous coal (pulverized). The plant utilizes the Ash Pond to manage the CCR and non-CCR wastestreams. The Ash Pond was constructed when the plant was built and has been in service for the life of the plant. The CCR wastestreams that are managed in the Ash Pond include sluiced bottom ash, economizer ash and Flue Gas Desulfurization (FGD) wastewater. All fly ash is now handled dry. The various non-CCR wastewaters routed to the Ash Pond originate from the Unit 1 and 2 boiler sumps, metal cleaning wastes, clarifier blowdown, bottom ash hopper seal water, miscellaneous drains including roof drains, landfill leachate, and various stormwater sources. A site plan is included in Appendix A.

### 2.1.1 CCR Inventory and Extent

Depth of impounded water and CCR is 3 feet and 18 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 396 feet and 400 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (October 2018) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 230,000 cubic yards (if CCR can be placed to the elevation of the current water surface). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of CCR currently stored in the Ash Pond is 1,000,000 cubic yards. The maximum storage capacity is 1,230,000 cubic yards. This volume was calculated based on the most recent bathymetric survey, and the best available as-built data for the construction prior to placement of CCR.

## 2.2 Closure Method

The CCR Rule allows for CCR Units to be closed through removal of CCR or by leaving CCR material in-place. BREC intends to close the existing Ash Pond using a hybrid approach by consolidating CCR material (approximately 1 million cubic yards) within the existing Ash Pond area. The CCR material would be consolidated along the south side of the existing pond, where it will be capped with a CCR compliant system. This area accounts for approximately 16 acres that will require a final cover.

The remaining 10 acres will be closed by removal of CCR. This area will then be used as a water mass balance pond (WMB) for processing and holding of landfill leachate and stormwater.

To facilitate construction of the new water mass balance (WMB) pond and the pond closure, the existing non-CCR wastestreams will need to be managed. The pond water level will be lowered as much as feasible after ceasing the receipt of CCR and the permanent cessation of the coal-fired boilers and prior to the construction contractor coming on site. When the construction contractor begins construction, the remaining non-CCR wastestreams (essentially site stormwater and landfill leachate after the boilers cease coal-fired operations) will be managed using a series of temporary berms, ditches, and pumps to divert site stormwater to other locations. This will likely require KPDES permit modifications following the permanent cessation of the coal-fired boilers operation and the remediation of the coal pile to discharge water from the existing coal pile runoff pond to the Green River. Alternatively, the Contractor may choose to maintain a small portion of the current Ash Pond footprint to continue to receive these flows and pump them through a temporary treatment system to the existing outfall structure. The sequencing of construction and means and methods for the water management will be determined by the construction contractor once a contract is finalized with BREC.

While managing the incoming stormwater and leachate flows, the Contractor will initiate grading and relocating CCR material for the WMB pond and pond closure and continue dewatering and removing the interstitial water in the CCR material (with drainage ditches or potentially an engineered dewatering system) so that the consolidated CCR material is stabilized to allow for the closure in place to be performed in phases to meet the performance standards as required by §257.102(d). The discharge will be directed to the KPDES permitted Outfall #009 (the Ash Pond outfall), with temporary treatment systems installed if required by the permit. As grading is completed in certain areas, the contractor will begin forming a 10-acre WMB Pond to treat remaining process and stormwater flows from Green prior to discharge. The approximate volume of CCR in the ash pond is 1,000,000 cubic yards. Approximately 400,000 cubic yards will be removed for the WMB pond construction. The Contractor will remove the CCR material from the portion of the impoundment that will receive the new WMB pond berm and begin placing fill for the new berm. While this fill is placed in lifts, the Contractor will continue removing CCR from the WMB portion of the pond and compacting it on the outside of the berm in the portion of the pond to be capped in place.

In addition to the new berm, the work for the WMB construction may consist of the installation of a HDPE geomembrane liner, 12-inches of protective cover material, and 18-inches of riprap for the pond side slopes. This liner system will be finalized during detailed design and permitting for the WMB Pond.

Concurrent to the WMB Pond lining work, the contractor will begin placing the final cover system over the closed in place CCR material.

When the grading is complete and the WMB is in service the remaining stormwater and non-CCR wastestreams (landfill leachate) will be rerouted to the new pond and will continue to discharge through the existing KPDES outlet. The contractor will then finalize construction by seeding and stabilizing all disturbed areas.

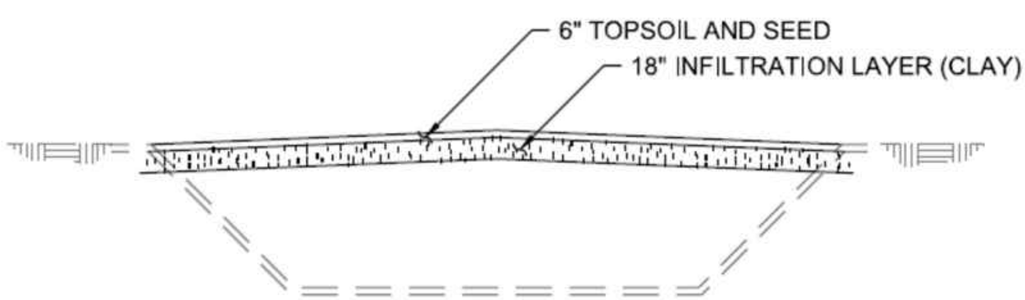
### 2.2.1 Final Cover System

Pursuant to §257.102(d)(3)(i), the final cover system must be designed and constructed to meet the following criteria:

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than $1x10^{-5}$ centimeters per second (cm/sec), whichever is less.
- The infiltration of liquids through the closed CCR unit must be minimized by use of an infiltration layer that contains a minimum of 18 inches of earthen material.
- The erosion of the final cover system must be minimized by use of an erosion layer that contains a minimum of six inches of earthen material capable of sustaining native plant growth.
- The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.
- The owner or operator may select an alternative final cover system design, provided the alternative final cover system meets the above requirements.

The typical final cover system will consist of an 18-inch thick, earthen (clay) infiltration layer with a 6-inch thick topsoil erosion layer capable of sustaining native plant growth. A cross section of the typical final cover system is shown in Figure 2-1.

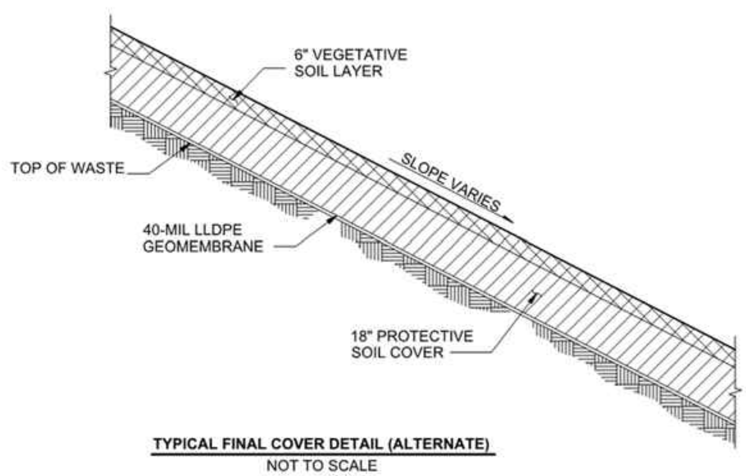
**Figure 2-1: Typical Final Cover System**



Because the Ash Pond bottom was not constructed to meet low permeability specifications, the cover system will be designed to meet the permeability limit of 1 x $10^{-5}$ cm/sec noted in the CCR Rule. The required permeability value will be achieved using clay with properties meeting the developed specification criteria. The infiltration layer will be constructed according to proper quality control methods.

An alternative final cover system may be utilized in lieu of the above described typical final cover system, over the Ash Pond (see Figure 2-2). This alternative system uses a geomembrane component to achieve the minimum permeability requirements of the CCR Rule, rather than relying on the permeability of the 18-inches of infiltration material.

**Figure 2-2: Typical Alternative Final Cover System**




### 2.2.1.1 Geometry and Stormwater Management

The geometry and stormwater management controls of the closed impoundment will allow the CCR unit to meet the following requirements as outlined in §257.102(d) of the CCR Rule:

- Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.
- Prevent future impoundment of water.
- Provide for slope stability to protect against sloughing or movement of the final cover system.

The final closure system grade will slope at a minimum of 2.0 percent over the capped Ash Pond surface to prevent the collection of standing water and limit the velocity of storm water runoff to reduce the potential for soil erosion. Intermediate swales will be utilized with a minimum slope of 2.0 percent, as appropriate, to limit the maximum overland flow distance, thereby limiting the chance for ponding water, as well as limiting the infiltration of run-off. The intermediate swales will collect area runoff and convey it to the WMB Pond which will discharge through an KPDES permitted outlet.

The period for greatest soil erosion will be immediately after placement of the topsoil material before vegetation is established. Manufactured erosion control products, as well as a seed mix containing quick-growth seed varieties, will aid in minimizing erosion during this timeframe.

#### 2.2.1.2 Integrity of the Final Cover

Settling and subsidence of the final cover system is expected to be minimal. Settlement would potentially be caused by consolidation of the CCR material or underlying natural subsoils under new loads from construction activities; however, this settlement will likely occur during site grading activities and is expected to be minimal after the cover is installed. CCR material will be placed in a controlled manner to minimize post-construction installation settlement. The underlying natural subsoils at the site are not prone to long-term settlement.

### 2.2.2 Final Cover Schedule

According to §257.101 of the CCR Rule, closure of the existing impoundment must commence no later than 6 months following the date on which a closure event is triggered, or no later than 30 days following the last known receipt of CCR or non-CCR wastewater by the impoundment. The current schedule is for BREC to cease sending CCR to the Ash Pond in the late spring of 2022. BREC intends to prepare design drawings, obtain the appropriate permits and award the contract for closure prior to removing the pond from service so that closure can commence within 30 days.

The estimated closure schedule is as follows:

| | |
|---|---|
| Mobilization | June 2022 |
| Pond Dewatering | June 2022 – August 2022 |
| Cut/Fill and Removal of CCR | August 2022 – May 2023 |
| Winter Shutdown | December 2022 – March 2023 |
| Install final cover system | May 2023 – July 2023 |
| WMB Construction | May 2023 – August 2023 |
| Topsoil and Seeding | August 2023 – September 2023 |
| Deadline to complete closure | October 17, 2023 |

#### 2.2.2.1 Closure Completion

The CCR Rule does not define "closure complete" for CCR units. For the purposes of this Closure Plan, closure of the impoundment is considered complete when the final cover system is installed, and the applicable construction completion documentation is finalized.

Within 30 days of completion of closure of the impoundment, BREC must prepare a notification of closure of the impoundment and place it in the facility's CCR Operating Record and on BREC's CCR public website. This notification shall include certification by a qualified professional engineer in the State of Kentucky verifying that closure has been completed in accordance with this Closure Plan and the requirements of §257.102. Additionally, BREC must record a notation on the deed to the property following completion of closure of the impoundment in accordance with §257.102(i). The purpose of this notation is to inform any potential future owner of the property of the previous use of the land, and that the land is restricted by post-closure care requirements.

# 3.0 REVISIONS AND AMENDMENTS

The initial Closure Plan was placed in the CCR Operating Record on October 11, 2016. If the Closure Plan is revised, the written Closure Plan will be amended no later than 30 days following the triggering event. Additionally, the written Closure Plan will be amended at least 60 days prior to a planned change in the operation of the Impoundment, or no later than 60 days after an unanticipated event. The initial Closure Plan and any amendment will be certified by a qualified professional engineer in the State of Kentucky for meeting the requirements of §257.102 of the CCR Rule. All amendments and revisions must be placed on the CCR public website within a reasonable amount of time following placement in the facility's CCR Operating Record. A record of revisions made to this document is included in Section 4.0 of this document.

# 4.0 RECORD OF REVISIONS AND UPDATES

| Date | Revisions Made | By Whom |
|---|---|---|
| 10/11/2016 | Initial Issue | Associated Engineers, Inc. |
| 09/13/2017 | Revision 1 | Associated Engineers, Inc. |
| 11/24/2020 | Revision 2 – Updated schedule and added detail to closure method | Burns & McDonnell |
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# APPENDIX A – SITE PLAN


NORTH
0 200' 400'
SCALE IN FEET

**PRELIMINARY - NOT FOR CONSTRUCTION**

| no. | date | by | ckd | description |
|---|---|---|---|---|
| A | 09/11/20 | MDB | ETT | ISSUED FOR OWNER REVIEW |

| no. | date | by | ckd | description |
|---|---|---|---|---|

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detailed: J. RIDDER

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Your Touchstone Energy® Cooperative
ROBERT D. GREEN STATION
WEBSTER COUNTY, KENTUCKY

BREC GREEN STATION
CCR & ELG COMPLIANCE PROJECT
ASH POND CLOSURE SITE PLAN

project: 126878
contract:
drawing: SK-C001
rev.: A
sheet of sheets
file 126878SK-C001.DGN

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