40 CFR Part 257.98
Corrective Action Groundwater Monitoring Plan
LCPA Surface Impoundment, Labadie Energy Center, Franklin County, Missouri

Submitted to:

Ameren Missouri
1901 Chouteau Avenue, St. Louis, Missouri 63103

Submitted by:

Golder Associates Inc.
13515 Barrett Parkway Drive, Suite 260, Ballwin, Missouri, USA 63021

+1 314 984-8800

153140602

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Revision History

Version	Date	Description
0	November 2019	Corrective Action Groundwater Monitoring Plan
1	May 1, 2020	Monitoring Wells AM-1S and AM-1D added to the Corrective Action Monitoring Well Network.

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1.0 INTRODUCTION

On August 30th, 2019, Ameren Missouri (Ameren) posted the "Selection of Remedy Report – 40 CFR § 257.97 Rush Island, Labadie, Sioux and Meramec CCR Basins" report to its publicly available website (Ameren 2019). This report selected the final remedy to be implemented to address groundwater contamination from the Bottom Ash Surface Impoundment (LCPA) at Ameren's Labadie Energy Center (LEC or Facility) in Franklin County Missouri (see location on **Figure 1**).

This Corrective Action Groundwater Monitoring Plan (GMP) was developed pursuant to § 257.98(a)(1) of "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule" (the CCR Rule). This section of the CCR Rule requires owners or operators establish and implement a Corrective Action GMP within 90 days of selecting a remedy. This Corrective Action GMP presents information on the design of the groundwater monitoring system, groundwater sampling and analysis procedures, groundwater statistical analysis methods, and data evaluation methods needed to complete the selected remedy of source control through installation of a low permeability cover system and use of Monitored Natural Attenuation (MNA) for groundwater impacts.

1.1 Overview of CCR Rule Activities for the LCPA

The CCR Rule was published in the Federal Register on April 17, 2015. This rule required CCR surface impoundments and landfills to monitor groundwater around these CCR units. Prior to the first major deadline of October 17, 2017, Ameren completed the following tasks: (1) installation of a groundwater monitoring well system; (2) a Statistical Method Certification; (3) a Groundwater Monitoring Plan (GMP) that details design, installation, development, sampling procedures, as well as statistical methods; and (4) eight baseline groundwater sampling events for all Appendix III and Appendix IV parameters of the CCR Rule. In November 2017, the first Detection Monitoring event was completed. Results from this event demonstrated some Appendix III parameters were present at concentrations that were a Statistically Significant Increase (SSI) over background and were then verified in January 2018 testing. In accordance with the CCR Rule, Ameren placed a "Notification of the Establishment of a CCR Assessment Monitoring Program" and began Assessment Monitoring within 90 Days.

Results from the Assessment Monitoring Events for the LCPA indicated the presence of molybdenum at a Statistically Significant Level (SSL) over background concentration in several of the compliance monitoring wells. As required, Ameren placed a "Notification of the Detection of Statistically Significant Levels Above CCR Groundwater Protection Standards" on its website and commenced an assessment of potential Corrective Measures. On August 30th, 2019, subsequent to a public meeting held to discuss those findings, Ameren selected a final remedy of source control through installation of a low permeability cover system and use of MNA. Ameren has posted a "Notification of intent to Close a CCR Unit and Certification for Final Cover Design" and has commenced closure of two CCR surface impoundments including the LCPA and intends to complete those closures by the end of 2020.

This Corrective Action GMP is designed to support the final remedy selection. At this time, molybdenum is the only parameter that was detected at an SSL above a site Groundwater Protection Standard (GWPS) and is the focus of the MNA analysis.

2.0 SITE SETTING

The LEC is located approximately 35 miles west of downtown St. Louis in Franklin County, Missouri. **Figure 1** depicts the location of the Facility and property boundaries referenced to local features and the Missouri River. The Facility encompasses approximately 2,400 acres and is located within the Missouri River Valley. The Facility is bounded to the north by the Missouri River, to the west by Labadie Creek, to the northeast and east by agricultural land and to the south by a railroad line and bedrock bluffs.

2.1 Coal Combustion Residuals (CCR) LCPA Surface Impoundment

The LCPA is in the floodplain of the Missouri River to the south of the LEC and is constructed with perimeter berms at an elevation of approximately 494 feet above mean sea level (feet MSL), which is above the 100-year flood elevation of 484 feet MSL. Both fly ash and bottom ash have been historically managed and stored in this surface impoundment. Construction drawings indicate that in the deepest portions of the CCR Unit the base depth of CCR extends down approximately ninety (90) feet to an elevation of approximately 400 feet MSL. Directly to the east of the LCPA are two additional CCR Units, the fly ash surface impoundment (LCPB) and the Utility Waste Landfill (UWL) Cell 1 (LCL1), which both have berm elevations above 488 feet MSL. To the south of the LCPA are lower elevation agricultural fields ranging from approximately 465 to 475 feet MSL. South of the railroad, bedrock bluffs rise to an elevation of over 600 feet MSL. The western side of the surface impoundment is bounded by a forested area and Labadie Creek, which flows north to the Missouri River.

2.2 Geology

2.2.1 Physiographic Setting and Regional Geology

The Facility area lies along the northeast margin of the Salem Plateau, a subsection of the Ozark Physiographic Province (USGS, 1994). In this region, the Salem Plateau is mainly comprised of Ordovician dolomite, limestone, and sandstone formations. To the northwest of the Labadie Bottoms area, the Salem plateau transitions into the geologically younger Mississippian and Pennsylvanian subsystems that are regionally known as glaciated plains (GREDELL Engineering Resources, Inc. (GREDELL) and Reitz & Jens, Inc. (Reitz & Jens), 2011). The approximate boundary between these two systems is the Missouri River, which is interpreted as being an ice-margin stream during the latest glacial epoch and defined the approximate southernmost progression of glaciation.

2.2.2 Local Geology

The geology immediately surrounding the Facility is composed of two distinctly different geological terrains; (1) floodplain deposits of the Missouri River Valley and (2) older sedimentary bedrock formations. Most of the Facility, including all of the plant infrastructure, the surface impoundments, and UWL lies within the Missouri River Valley, locally referred to as the Labadie Bottoms. The Missouri River Valley in this region is an approximately 2- to 3-mile-wide area of floodplain with alluvial deposits (alluvium) that are the result of the water flow and deposition from the Missouri River. Based on the Surficial Material Geologic Map of the Labadie 7.5' quadrangle (Butler and Siemens, 2010), borings logged by Golder (Golder 2017a, Golder 2017b, Golder 2017c, Golder 2018a, Golder 2018b, Golder 2018c, Golder 2019a, Golder 2019b, Golder 2019c) and borings conducted during the Detailed Site Investigation (DSI) for the nearby utility waste landfill (UWL) (GREDELL and Reitz & Jens, 2011), the alluvial deposits are typically comprised of sands and gravels with lesser amounts of silts and clays, generally resulting in an overall fining-upward sequence.

The depth of the alluvial deposits near the surface impoundment typically range from approximately 90 to 130 feet below ground surface (BGS) (365 to 385 feet MSL) with total depths in the area as deep as 135 feet BGS and becoming shallower towards the bluffs to the south based on site-specific borings. Sedimentary bedrock underlies the alluvial deposits.

Bluffs to the south, as well as bedrock underlying the floodplain alluvial deposits, are comprised of relatively flat-lying Ordovician-aged limestones, sandstones and dolomites. In progression from youngest to oldest, these deposits consist of the Plattin Group, Joachim Dolomite, St. Peter Sandstone, Powell Dolomite, and the Cotter/Jefferson City Dolomites (Starbuck, 2010; GREDELL and Reitz & Jens, 2011). In deep wells, the Roubidoux Formation and the underlying Gasconade Dolomite can be found at depths of approximately 530-764 feet below ground surface (GREDELL and Reitz & Jens, 2011). **Figure 2** provides a generalized north-south depiction of the surface impoundment referenced to local geology, groundwater, and the Missouri River.

2.3 Site Hydrogeology

Site hydrogeology has been characterized based on information obtained from over 200 piezometers and borings completed at the LEC by GREDELL and Reitz & Jens to support a DSI conducted for the Labadie UWL, the CCR Rule groundwater monitoring wells completed by Golder, monitoring wells installed around the perimeter of the UWL by Reitz and Jens for state required UWL groundwater monitoring and monitoring wells installed for National Pollutant Discharge Elimination System (NPDES) permitting requirements.

2.3.1 Uppermost Aquifer

As required by the CCR Rule, a groundwater monitoring system was installed in the uppermost aquifer around each CCR Unit (§257.91(a)). As shown on **Figure 2**, the uppermost aquifer beneath the CCR impoundments and landfills is the alluvial deposits consisting primarily of alluvial sands with some silt, clay, and gravel associated with the Missouri River Valley alluvium. This alluvium overlies Ordovician-aged sedimentary bedrock formations. As generally described above, these alluvial deposits typically exhibit a fining-upward sequence with some silts and clays present within the shallow zone and mostly coarse sands and gravels present at depth.

2.3.2 CCR Surface Impoundment Water Elevations

Prior to initiating closure, pond gauge readings were collected concurrently with groundwater measurements from each CCR Rule sampling event. During this time, LCPA pond levels ranged from approximately 482 to 487 feet MSL. These elevations were approximately 18 to 32 feet above the natural groundwater elevations surrounding the pond (**Table 1**). The difference between the pond level and the natural groundwater elevation was greatest when the Missouri River level was low and the pond operating in a full condition. Data show water mounding within the LCPA regardless of the river level; however, the mounding was less pronounced at times of high river level.

After initiating closure, however, the static water level in the pond has dropped and is now approximately equal with the surrounding alluvial aquifer static groundwater levels. This has removed the mounding effects of the active operating conditions. It is expected that the static water level in the LCPA will remain similar to the surrounding alluvial aquifer after closure of the CCR unit is completed.

2.3.3 Alluvial Aquifer Groundwater Elevations

Groundwater elevations within the alluvial aquifer in the Labadie bottoms area have been obtained in several different studies. As a part of the DSI for the UWL, groundwater elevations were obtained within the alluvial aquifer approximately 2,500 feet to the east of LCPA from December 2009 to November 2010. These

piezometers were all located in the alluvial aquifer and had screen intervals ranging from approximately 428 to 452 feet MSL. Groundwater elevation measurements ranged from approximately 456 to 469 feet MSL during this time period. However, during any single round of groundwater level measurements, the aquifer potentiometric surface was relatively flat, with the surface variability in any round of groundwater level measurements ranging from approximately 1 to 4 feet across all of the piezometers. Potentiometric Surface Maps displaying these results are provided in Appendix A.

Golder obtained groundwater elevation measurements from March 2016 through October 2019 within the alluvial aquifer. For each of the sampling events, groundwater elevations were measured at monitoring wells within a 24-hour timeframe and a potentiometric map was generated from the data (**Appendix B** and **Table 1**). Groundwater elevations ranged from approximately 451 feet MSL to 471 feet MSL.

2.3.4 Alluvial Aquifer Groundwater Flow Direction

Groundwater flow within the alluvial aquifer is dynamic and is influenced by seasonal changes in the water level in the adjacent Missouri River. River water levels measured at the Facility display large seasonal changes in the elevation of the Missouri River water surface. For example, from the CCR Rule monitoring (April 2015 through October 2019), Missouri river water levels fluctuated between approximately 449 and 476 feet MSL (**Figure 3**, USGS, 2019). Water flows into and out of the alluvial aquifer as a result of fluctuating river water levels that produce “bank recharge” and “bank discharge” conditions. Under normal aquifer conditions, groundwater flow in the alluvial aquifer would be expected to flow toward the river and away from the bluffs, with a likely net flow direction generally to the north.

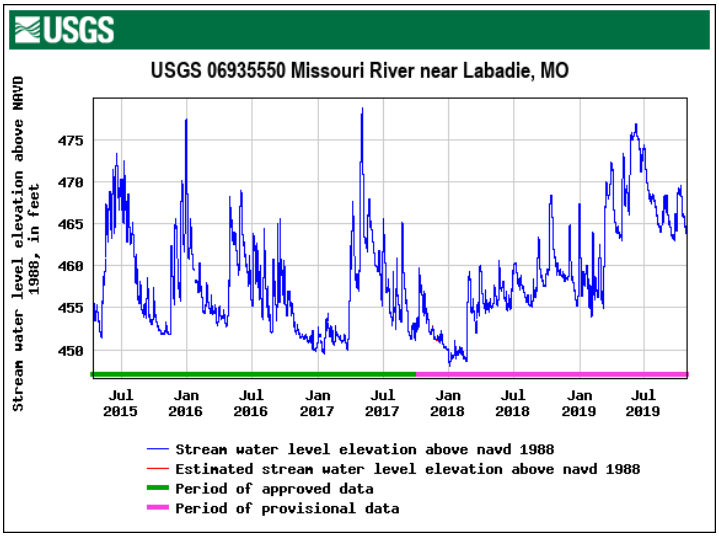

Figure 3: USGS Missouri River Elevation at LEC

Although the movement of groundwater within the alluvial aquifer at the Facility is complex, the movement has been characterized by frequent groundwater elevation measurements and the generation of potentiometric surface maps generated by GREDELL, Reitz & Jens and Golder (**Appendix A**, **Appendix B** and **Table 1**). As expected, the potentiometric surface maps display variability in the groundwater flow direction and these changes in flow direction are related to the water level within the adjacent Missouri River.

In addition to the DSI potentiometric surface maps, additional groundwater analysis was also completed as a part of the UWL Construction Permit Application (GREDELL and Reitz & Jens, 2014). These analyses calculated the

net groundwater flow velocity and direction from December 2009 until November 2010. During this timeframe, groundwater located near proposed UWL cells 1 & 2 was calculated to have a net annual velocity of approximately 12 feet per year with a bearing of 33° (North-northeast). Groundwater located near UWL cells 3 & 4 was calculated to have a net annual flow velocity of approximately 15 feet per year with a bearing of approximately 67° (East-northeast). The UWL results also displayed that groundwater flow direction was highly variable from month to month depending on Missouri River conditions with overall flow directions ranging from a west-northwesterly direction to a southeasterly direction.

Groundwater flow direction and hydraulic gradient were estimated for the CCR wells (Devlin 2002). Estimated results from this analysis are provided in **Table 2**. These results indicate that while groundwater flow direction is variable (333º to 90º (northwest to east)), overall net groundwater flow from 2015 to 2019 was generally towards the north/north-northeast, flowing from the bluffs toward the river.

Based on all of the data and potentiometric surface maps produced to-date, a general flow direction from the south (bluffs area) to the north (Missouri River) under normal river conditions is expected. However, during periods of high river levels, groundwater flow can temporarily reverse and flow southward. During these times of high river stage and temporary flow direction changes, horizontal groundwater gradients generally decrease and little net movement of groundwater to the south occurs.

Horizontal and vertical groundwater flow within the uppermost aquifer have been locally influenced by operation of the LCPA surface impoundment prior to commencing closure. Ponding of water in the LCPA at elevations greater than the static water levels in the underlying alluvial aquifer groundwater created a localized mounding effect, resulting in localized downward gradients and localized radial groundwater flow outward from the impoundment. Since closure, these downward gradients have been greatly reduced and effectively eliminated. The full effects of the closure on groundwater elevations will continue to be monitored after CCR unit closure is completed, to see if there are any major changes to groundwater flow between active and closed conditions.

2.3.4.1 Horizontal Gradient

Horizontal groundwater gradients in the alluvial aquifer are typically low and flat. The gradients are very dependent on river water levels (bank recharge and bank discharge conditions described earlier). Horizontal flow gradients calculated for the UWL DSI ranged from 0.000002 to 0.0035 feet/foot. The DSI indicates that the higher gradients were observed closer to the Missouri River and reflect localized river influence and are not representative of site-wide conditions farther from the river. Gradients calculated as a part of the UWL monitoring display similar results to the DSI with groundwater gradients ranging from 0.000002 to 0.00756 feet/foot.

Site-wide horizontal gradients were also calculated for each of the CCR groundwater baseline sampling events and the results of these are displayed on **Table 2**. The horizontal groundwater gradients are low, ranging from 0.0001 to 0.0007 feet/foot.

A review of the potentiometric surface maps confirms the gradient estimates for a larger scale, but also demonstrates that localized horizontal gradients can be higher especially in areas near the Missouri River.

2.3.4.2 Vertical Gradient

A review of downward gradients observed in piezometers was completed by comparing groundwater elevations obtained by Golder during CCR Rule monitoring. This analysis was completed by comparing water levels from shallow and intermediate/deep zone piezometer locations where the piezometers are nested (two or more piezometers in close proximity, screened at different elevations). **Appendix C** provides figures that display the

vertical gradients over time from the different well pairs. From the review of these data, areas away from the LCPA show relatively variable vertical gradients that fluctuate between upward and downward with no consistent vertical gradient present between shallow and deeper zones of the alluvial aquifer. The average vertical gradient in these wells is 0.00011 (very slightly upward), which further demonstrates the relatively flat gradient. In the area adjacent to the LCPA (LMW-2S vs UMW-5D) there has historically been a slight downward gradient when the pond was active, with an average gradient of -0.0017 (slightly downward). This was likely caused by the mounding present in the LCPA during active conditions. However, since the LCPA no longer receives CCR or water, the gradients now appear to be stabilizing and are reflective of the surrounding aquifer.

2.3.5 Hydraulic Conductivity and Groundwater Velocity

In-situ hydraulic conductivity tests (slug tests) were conducted as part of the DSI within the shallow portion of the alluvial aquifer in the area of the UWL. The hydraulic conductivity in the area is highly dependent of the geology present within the screening interval of the piezometer. Estimates of the hydraulic conductivity within the aquifer were made using data acquired from slug tests in 25 piezometers. The calculated hydraulic conductivity of the fluvial sediments ranges from 1.01×10^{-2} to 4.81×10^{-2} centimeters/second (cm/s) with an average value of 2.49×10^{-2} cm/s. Generally, there is a tendency toward higher hydraulic conductivity values where the screened interval intersects with relatively coarse-grained sands interpreted as channel deposits. For relatively homogenous flood plain/levee sequences containing fine-grained sediments, calculated values are demonstrably lower. Similarly, in piezometers where the screen interval intersects finer-grained, clayey backswamp/cut-off deposits, the DSI indicates lower hydraulic conductivity values were measured.

Groundwater flow velocities were calculated as a part of the DSI using these hydraulic conductivity values, hydraulic gradients, and an estimated value for effective porosity (Table 8 of the DSI). The DSI suggests a representative range of prevailing groundwater movement at the site is between 0.1 and 10 feet per year, depending on hydraulic conductivity and effective porosity.

Golder performed rising head hydraulic conductivity tests using a pneumatic slug (Hi-K slug) and a downhole pressure transducer on the LEC CCR monitoring wells to estimate hydraulic conductivities. The results of Golder's hydraulic conductivity testing displayed a range from 1.1×10^{-2} cm/sec to 4.5×10^{-2} cm/sec and an estimated geometric mean of approximately 2.1×10^{-2} cm/sec for the CCR groundwater monitoring wells in the alluvial aquifer at the LEC.

Estimated groundwater flow velocities were calculated using the CCR monitoring well hydraulic conductivity, hydraulic gradients and an estimated value for effective porosity (**Table 2**). Using these values, groundwater flow velocities are estimated to range between 0.03 and 0.1 feet per day, and average approximately 17 feet per year in the prevailing downgradient direction.

2.3.6 Porosity and Effective Porosity

Porosities were estimated based on the grain size distributions of an aquifer soil sample collected during monitoring well drilling. A representative grain size distribution was collected from the screen interval at UMW-6D and LMW-1S using the ASTM D6912 Method B and the results are provided in the GMPs for the LCPA and LCPB. These samples were similar in field classification to other well drilling samples and the results indicate that the screened intervals of the alluvial aquifer are mostly comprised of sand (at least 85%) with lesser amounts of gravel, silt and clay. Also, the typical grain size of the sand ranges from fine to coarse sand. Textbook values of porosities for sands and sand/gravel mixes range from 25-50% (Fetter, 2000, and Freeze and Cherry, 1979) and

fine sands typically range from 29-46%, whereas coarse sands typically range from 26-43% (Das, 2008). An average porosity of 35% is estimated for the alluvial aquifer based on the site data.

Effective porosity is the porosity that is available for fluid flow. Studies completed in unconsolidated sediments have determined that water molecules pass through all pores and the effective porosity is approximately equal to the total porosity (Fetter, 2000). Therefore, the effective porosity of the alluvial aquifer is also estimated to be 35%.

3.0 GROUNDWATER MONITORING PROGRAM

3.1 Groundwater Monitoring Well Network

For Corrective Action, the CCR Rule requires a demonstration that compliance with the GWPS has been achieved at all points within the plume of contamination that lie beyond the initial Detection and Assessment Monitoring well networks (§ 257.98(c)(1)). Monitoring wells to be used for this network are identified below in **Table 3** and their locations, in addition to the wells used for Detection and Assessment Monitoring are provided in **Figure 4**.

Table 3 –Corrective Action Groundwater Monitoring Well Network

Shallow Zone of the Alluvial Aquifer	Intermediate/Deep Zone of the Alluvial Aquifer
BMW-1S	TP-1D
BMW-2S	TP-2M
LMW-1S	TP-2D
LMW-2S	TP-3M
LMW-4S	TP-3D
LMW-7S	TP-4D
LMW-8S	MW-33(D)
MW-24	MW-34(D)
MW-26	MW-35(D)
S-1	AMW-8
AM-1S	AM-1D

3.2 Groundwater Sampling Frequency and Parameters

3.2.1 CCR Rule Minimum Requirements

The CCR Rule has specific minimum requirements for sampling frequency and parameters. At a minimum, sampling must meet the requirements of an Assessment Monitoring Program (§257.98). Therefore, the minimum monitoring well sampling frequency would be three sampling events the first year, followed by semi-annual sampling thereafter. Minimum requirements for sampling parameters are that all Appendix IV parameters must be tested at least annually, with only detected Appendix IV parameters required for subsequent events. Appendix III Parameters must also be analyzed at least semi-annually. **Table 4** displays the parameters associated with Appendix III and IV, as well as other MNA parameters.

Table 4 – Sampling Parameters List

Groundwater Parameters			
Parameter	**Method**	**Parameter**	**Method**
Appendix III Parameters		**Cations & Anions**	
Boron	200.7	Alkalinity	SM 2320B
Calcium	200.7	Iron	200.7
Chloride	EPA 300.0	Magnesium	200.7
Fluoride	EPA 300.0	Manganese	200.7
pH	NA	Potassium	200.7
Sulfate	EPA 300.0	Sodium	200.7
Total Dissolved Solids	SM2540C	**Other Parameters**	
Appendix IV Parameters		Sulfide	SM4500-S2D
Antimony	200.8	**Iron Speciation**	
Arsenic	200.8	Ferrous Iron	SM3500-Fe-D
Barium	200.7	Ferric Iron	Calculation
Beryllium	200.7		
Cadmium	200.8		
Chromium	200.8		
Cobalt	200.7		
Fluoride	EPA 300.0		
Lead	200.7		
Lithium	200.7		
Mercury	EPA7470A		
Molybdenum	200.7		
Radium 226	EPA 903.1		
Radium 228	EPA 904.0		
Selenium	200.8		
Thallium	200.8		

Notes:

1) The methods provided are those currently used for Detection/Assessment Monitoring. Methods may be adjusted in the future as analytical methods evolve and detection limit adjustments are needed.

3.2.2 Prior to Completion of Source Control

The first step in the selected remedy is to provide source control through the installation of a low permeability cover system. This step is currently in process. In the time prior to the cap completion, the requirements of the CCR Rule will be met with completion of three sampling events for the Corrective Action Monitoring wells in 2020 as follows:

1) Q2 2020 (~April) – An initial sampling event for all Appendix IV parameters at all Monitoring Wells

2) Q2 2020 (~May) – Sampling event within 90 days for all detected Appendix IV Parameters and all Appendix III parameters.

3) Q4 2020 (~November) – Semi-annual sampling event for all detected Appendix IV parameters and all Appendix III parameters.

These sampling events are subject to change depending on unforeseen conditions such as flooding, etc.

In addition to the requirements of the CCR Rule, in order to complete Corrective Action statistical analysis, a minimum of 4 samples are required and 8 samples are recommended by the Unified Guidance (USEPA 2009). Parameters that have been detected at an SSL should have a minimum of 8 sample results for analysis prior to LCPA closure completion.

Also, several parameters such as major cations/anions, iron speciation and sulfide are very beneficial for MNA analysis and are needed to demonstrate that MNA is occurring. Major cations and anions will be tested from each Corrective Action monitoring well sample during the three required sampling events. Iron speciation and sulfide will be tested annually along with the sampling event for all Appendix IV and III parameters. **Table 4** provides a list of the parameters to be sampled for groundwater sampling.

3.2.3 Long-Term Performance Monitoring

Once source control is completed, long-term monitoring of MNA and statistical compliance will be initiated. In order to comply with the requirements of the CCR Rule, sampling will be completed on a semi-annual basis. For this sampling, the first sampling event each year will test for all Appendix III and IV parameters. Additionally, for MNA evaluation, major cations, anions, iron speciation, and sulfide will be tested. During the second event of each year, samples will be tested for Appendix IV parameters that were detected during that year's first sampling event, and all Appendix III parameters and major cations/anions will be tested.

3.3 Groundwater Level Measurements

To meet the requirements of §257.93(c), water level measurements will be taken at all monitoring wells to be sampled and prior to the start of any groundwater purging at the monitoring well. These measurements will be taken within a 24-hour period and will be recorded on the Record of Water Level Readings form or Groundwater Sample Collection Form. Static water levels will be measured in each monitoring well prior to purging using an electric meter accurate to 0.01-foot. The measuring probe will be rinsed with distilled or deionized water before and after use at each well. In addition, other monitoring wells or piezometers that may be beneficial for groundwater elevation mapping may also be collected.

3.4 Groundwater Sampling Methods and Procedures

Sampling will be performed in accordance with generally accepted practices within the industry and Missouri requirements. **Appendix D** provides details of procedures used to collect groundwater samples.

4.0 DATA EVALUATION AND REPORTING

The following sections describe the evaluation and analysis procedures that are followed upon receipt of the laboratory analytical data.

4.1 Evaluation of Rate and Direction of Groundwater Flow

Groundwater elevations will be determined for each sampling event and will be used to develop a groundwater elevation contour map that will be submitted with reports. The direction of groundwater flow will be determined from up- and downgradient relationships as depicted on the potentiometric surface map. Based on these maps, groundwater flow velocities will be estimated for each event as well as groundwater flow directions. Additional software or analysis (Modflow, USEPA gradient calculator, etc.) may also be used as applicable for groundwater flow analysis.

4.2 Data Validation

Before the data are used for statistical analysis, they will be evaluated by examining the quality control data in the laboratory report. Relevant quality control data could include measures of accuracy (percent recovery), precision (relative percent difference, RPD), and sample contamination (blank determinations). Data that fail any of these checks will be flagged for further evaluation. A Data Quality Review (DQR) may be initiated with the laboratory for anomalous data.

4.3 Statistical Evaluations for Corrective Action

Upon completion of the data validation, Corrective Action statistical analysis will be completed to determine if groundwater concentrations are present at a level statistically above or below the site-specific GWPS. As required in the CCR Rule, a statistical evaluation of the groundwater data must be completed within 90 days of receiving data from the laboratory. Once the statistical evaluation is completed, the results will be placed in the operating record. The data will be analyzed using the methods and procedures outlined in the Statistical Analysis Plan (**Appendix E**).

As specified in 257.98(C) of the CCR Rule, in order to complete Corrective Action Monitoring the following must be demonstrated:

- Compliance with the GWPS at all points within the plume of contamination that lie beyond the Detection/Assessment Monitoring groundwater monitoring well system.
- Compliance with the GWPS where concentrations of constituents listed in Appendix IV to this part have not exceeded the GWPS for a period of three consecutive years.

Additionally, because Corrective Action and its effects on the groundwater regime should result in changes in plume concentrations and size over time, individual monitoring wells may be removed from Corrective Action Monitoring once concentrations are below the GWPS for three consecutive years. As outlined in the CCR Rule, the Corrective Action Program will be deemed complete once all points within the plume beyond the Detection/Assessment Monitoring groundwater monitoring well system are statistically within compliance of the GWPS for three consecutive years. Once this demonstration can be made, a notification stating that the remedy has been completed is required to be posted to the operating record and the publicly available website. This notification must be certified by a Professional Engineer.

4.4 Data Evaluation to Demonstrate MNA

The CCR Rule (§ 257.98(a)(1)(ii)) requires that the Corrective Action GMP provide a way to document the effectiveness of the Corrective Action remedy. The statistical analysis is required by the CCR Rule in order to determine when monitoring wells are in compliance with the GWPS and are the basis of removing the LCPA from Corrective Action, however, these statistical methods do not directly indicate if MNA is occurring. Multiple lines of

evidence and analysis can be used to evaluate the effectiveness of the remedy. Methods that may be used for evaluating and demonstrating the MNA is occurring are as follows:

1) **Well Specific Constituent Trend Graphs:** Constituent concentration versus time graphs can be used to determine if concentrations are behaving as anticipated or if unexpected conditions are occurring. Decreasing trends of constituents over time can be used to assess the progress of MNA. Increasing trends could represent a new source, unanticipated plume behavior, a change in ambient conditions, or a possible increase of transformation products.

2) **Concentration Maps:** Concentrations of constituents plotted in 2D, 3D, or cross-sectional view can be used to define the extents and concentrations within the plume at a given time. Comparison of the plume extents, location, size, configuration, concentrations, and center of mass which will allow for an assessment of MNA progress and an identification of potential migration patterns.

3) **Geochemical Analysis:** Completion of geochemical analysis such as Piper and Stiff diagrams can provide information on water chemistry changed over time and/or spatial area. Changes in chemistry over time can show that MNA is occurring. Changes may also identify possible changes in ambient conditions, which may change estimates of MNA timeframes, etc.

These methods are examples of initial methods to evaluate MNA and remedy effectiveness. Other methods may be used in the evaluation as the monitoring program progresses.

4.5 Verify no Adverse Impacts to Downgradient Receptors

One key objective in any MNA program is to verify that there are no adverse impacts to downgradient receptors. Numerous human health risk assessments for the site (Golder 2012, AECOM 2014, Kleinfelder 2016, and Haley & Aldrich 2018) have been completed. From these assessments, the potential downgradient receptors are:

1. Users of the Missouri River including people who used the river for recreational activities that may bring them into direct contact with the river.
2. The drinking water intake located approximately 19.5 miles downstream from the LEC at Howard Bend.

Multiple rounds of surface water samples collected from the Missouri River adjacent to the LEC have shown no impact from the LEC to the Missouri River. Calculated Risk-Based Screening Levels for the Missouri River level were generated in the Haley & Aldrich 2018 report that provides a conservative groundwater target level (or threshold) that is protective of the river. For each constituent, the lowest of the human health drinking water, recreational, and ecological screening levels is used. A dilution factor (100,000 for the Missouri River at the LEC) is then applied to the lowest screening level for surface water and results in the Calculated Risk-Based Screening Level.

In order to verify that there are no adverse impacts to downgradient receptors, groundwater concentrations adjacent to the Missouri River will continue to be monitored, and if concentrations in these monitoring wells reach the calculated risk-based thresholds, the following actions will be taken:

- The monitoring well that displayed the impacts will be re-sampled for verification.
- If verified, a surface water sampling plan will be prepared and surface water sampling in the Missouri River will be completed.

4.6 Monitoring Well Network Review and Long-Term Monitoring Well Network Optimization

Annual review of the monitoring well network will be completed to evaluate if the current network is still accurately monitoring MNA at the site. This review will be completed to determine if any monitoring wells should be added or removed from the network. This review will be based on data reviews completed above, as well as professional judgment. In addition, monitoring well network optimization programs may be used to determine if any changes to the network are warranted.

4.7 Supplemental Corrective Measures

Groundwater treatment technologies are being evaluated to determine if treatment may be able to supplement the selected remedy. Pilot studies and additional treatment testing may be performed at the LEC as a supplemental corrective measure. If treatment is to be used as a supplemental corrective measure, this monitoring plan may be updated to include the groundwater monitoring requirements and methods associated with evaluating and monitoring the supplemental corrective measure.

4.8 Annual Groundwater Monitoring and Corrective Action Report

In addition to the periodical reporting listed above, an annual groundwater monitoring report will be prepared according to the requirements of 40 CFR §257.90(e). At a minimum, the annual groundwater monitoring report will contain the following information:

- The current status of the groundwater monitoring program
- A projection of key activities planned for the upcoming year
- A map showing the CCR unit and all background (or upgradient), compliance monitoring wells installed under § 257.91 of the CCR Rule (LCPA GMP, Detection and Assessment Monitoring well network), and the Corrective Action Monitoring well network discussed in this GMP
- A discussion of any monitoring wells that were installed or decommissioned during the preceding year or any other changes made to the groundwater monitoring system
- Analytical results from groundwater sampling required by Detection, Assessment and Corrective Action Monitoring
- A demonstration, if appropriate, for an alternative groundwater sampling frequency for Detection, Assessment or Corrective Action Monitoring
- The monitoring data obtained under §§ 257.90 through 257.98, including a summary of the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the Detection, Assessment or Corrective Action Monitoring
- A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from Detection Monitoring to Assessment Monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels)

- If required, an alternate source demonstration that is certified by a Professional Engineer demonstrating that any new Detection or Assessment Monitoring SSIs or SSLs over background are not due to the release from the Facility
- A listing of GWPS for both Assessment and Corrective Action Monitoring

In addition to the requirements of the CCR Rule, additional information on the evaluation of MNA, treatability studies, or risk assessments may also be included in the Annual Report, if applicable.

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Tables

Table 1
Groundwater Elevation Measurements
Labadie Energy Center
Franklin County, Missouri

Groundwater Monitoring Well Program	Well ID	Location		Top of Casing	Ground Surface	Date Installed	Date Abandoned	Groundwater Elevation Measurements 3/22/2016		Groundwater Elevation Measurements 5/3/2016		Groundwater Elevation Measurements 7/11/2016	
		Northing	Easting	Feet MSL[3]	Feet MSL[3]			DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]
LCPA CCR[8] Wells	UMW-1D	988822.5	723129.4	489.72	487.8	11/19/2015	NA	30.90	458.82	26.00	463.72	27.32	462.40
	UMW-2D	990437.2	722248.6	484.81	482.7	11/21/2015	NA	26.76	458.05	21.13	463.68	22.87	461.94
	UMW -3D**	991830.7	723558.8	490.62	488.8	11/22/2015	10/25/2018	32.67	457.95	27.66	462.96	29.02	461.60
	UMW -3D(r)**	991823.5	723545.1	491.13	488.8	10/25/2018	NA	NA	NA	NA	NA	NA	NA
	UMW-4D	992512.3	724538.1	494.95	493.2	11/24/2015	NA	36.98	457.97	32.67	462.28	33.55	461.40
	UMW-5D	992027.2	725067.9	496.76	494.9	11/23/2015	NA	38.53	458.23	34.67	462.09	35.24	461.52
	UMW-6D	991382.8	725540.9	496.19	494.5	11/22/2015	8/16/2019	37.71	458.48	34.14	462.05	34.50	461.69
	UMW-6D***	991382.8	725540.9	492.51	490.8	8/16/2019	NA	NA	NA	NA	NA	NA	NA
	UMW-7D	990722.8	726032.4	469.79	468.0	11/20/2015	NA	11.09	458.70	7.93	461.86	8.06	461.73
	UMW-8D	989892.7	725179.5	469.47	467.5	11/19/2015	NA	10.25	459.22	6.78	462.69	6.98	462.49
	UMW-9D	989220.0	724447.8	470.61	468.8	11/19/2015	NA	11.22	459.39	7.25	463.36	7.86	462.75
	BMW-1D	988310.6	715138.4	473.54	471.2	2/1/2016	NA	16.49	457.05	9.33	464.21	12.00	461.54
	BMW-2D	987204.3	715104.2	474.39	472.4	2/2/2016	NA	17.03	457.36	11.32	463.07	12.37	462.02
	AM-1S	995288.1	723817.1	483.00	480.2	5/31/2018	NA	NA	NA	NA	NA	NA	NA
	AM-1D	995298.6	723827.3	482.78	480.0	5/31/2018	NA	NA	NA	NA	NA	NA	NA
LCPB CCR[8] Wells	LMW-1S	990727.7	726039.1	470.06	468.1	11/20/2015	NA	11.10	458.96	8.33	461.73	8.14	461.92
	LMW-2S	992017.5	725074.2	496.64	494.9	11/23/2019	NA	38.34	458.30	34.49	462.15	35.06	461.58
	LMW-3S	993254.3	725081.6	492.56	490.5	2/2/2016	NA	34.74	457.82	30.79	461.77	31.41	461.15
	LMW-4S*	994194.9	725624.1	472.88	470.7	11/18/2015	NA	15.23	457.65	12.60	460.28	11.93	460.95
	LMW-4S*	994194.9	725624.1	472.83	470.6	10/26/2018	NA	NA	NA	NA	NA	NA	NA
	LMW-5S	994201.6	726366.8	468.75	466.9	11/18/2015	NA	10.99	457.76	8.75	460.00	7.80	460.95
	LMW-6S	993320.2	726391.4	469.56	467.2	11/20/2015	NA	11.57	457.99	8.99	460.57	8.50	461.06
	LMW-7S	992330.1	726371.1	468.43	466.7	11/20/2015	NA	10.30	458.13	7.26	461.17	7.25	461.18
	LMW-8S	991371.2	726351.3	467.24	465.2	11/20/2015	NA	8.85	458.39	5.84	461.40	5.84	461.40
	BMW-1S	988310.0	715131.6	473.49	471.2	2/1/2016	NA	16.40	457.09	9.40	464.09	11.89	461.60
	BMW-2S	987210.1	715104.3	474.56	472.5	2/2/2016	NA	17.15	457.41	11.77	462.79	12.44	462.12
LCL1 CCR[8] Wells	TMW-1	993782.9	728656.8	469.34	466.9	3/20/2013	NA	NA	NA	10.12	459.22	8.83	460.51
	TMW-2	994513.1	728663.8	470.40	468.0	3/19/2013	NA	NA	NA	10.40	460.00	10.05	460.35
	TMW-3	994635.7	727842.0	469.41	467.1	4/6/2016	NA	NA	NA	9.35	460.06	8.84	460.57
	MW-26	993976.5	726910.9	469.20	466.7	4/6/2016	NA	NA	NA	9.20	460.00	8.27	460.93
Utility Waste Landfill Wells	MW-1	995572.0	727213.0	472.05	469.5	3/21/2013	NA	NA	NA	NA	NA	NA	NA
	MW-2	995657.0	727664.0	471.86	469.3	3/21/2013	NA	NA	NA	NA	NA	NA	NA
	MW-3	995739.6	728101.2	471.01	468.5	3/21/2013	NA	NA	NA	NA	NA	NA	NA
	MW-4	995818.4	728546.3	470.96	468.3	3/21/2013	NA	NA	NA	NA	NA	NA	NA
	MW-5	995545.8	728819.2	470.06	467.4	3/22/2013	NA	NA	NA	NA	NA	NA	NA
	MW-6	995177.0	729226.7	469.68	467.1	4/4/2013	NA	NA	NA	NA	NA	NA	NA
	MW-7	994621.5	729411.4	469.15	466.7	4/4/2013	NA	NA	NA	NA	NA	NA	NA
	MW-8	994382.7	729643.2	468.25	465.6	3/26/2013	NA	NA	NA	NA	NA	NA	NA
	MW-9	994168.3	729892.6	467.81	465.1	3/26/2013	NA	NA	NA	NA	NA	NA	NA
	MW-10	993950.5	730148.7	468.56	465.8	3/26/2013	NA	NA	NA	NA	NA	NA	NA
	MW-11	993724.6	730398.4	468.55	466.1	3/26/2013	NA	NA	NA	NA	NA	NA	NA
	MW-12	993469.5	730622.5	468.11	465.7	4/8/2013	NA	NA	NA	NA	NA	NA	NA
	MW-13	993255.5	730912.8	468.10	465.6	4/8/2013	NA	NA	NA	NA	NA	NA	NA
	MW-14	993052.3	731166.4	466.83	464.2	3/27/2013	NA	NA	NA	NA	NA	NA	NA
	MW-15	992807.3	731405.9	467.30	465.0	4/8/2013	NA	NA	NA	NA	NA	NA	NA
	MW-16	992617.6	731651.2	466.57	464.0	3/28/2013	NA	NA	NA	NA	NA	NA	NA
	MW-17	992302.1	731675.3	467.89	465.3	4/1/2013	NA	NA	NA	NA	NA	NA	NA
	MW-18	991677.7	730928.2	465.27	462.8	4/1/2013	NA	NA	NA	NA	NA	NA	NA
	MW-19	992089.0	730177.6	466.16	463.5	4/1/2013	NA	NA	NA	NA	NA	NA	NA
	MW-20	991669.1	729951.7	465.97	463.6	4/4/2013	NA	NA	NA	NA	NA	NA	NA
	MW-21	991334.0	729950.0	465.90	463.4	4/4/2013	NA	NA	NA	NA	NA	NA	NA
	MW-22	990929.1	729354.6	466.80	464.2	3/19/2013	NA	NA	NA	NA	NA	NA	NA
	MW-23	991099.5	728511.5	467.54	464.9	3/20/2013	NA	NA	NA	NA	NA	NA	NA
	MW-24	991818.3	727992.3	467.10	464.6	3/20/2013	NA	NA	NA	NA	NA	NA	NA
	MW-25	992706.9	727528.7	468.61	466.0	3/20/2013	NA	NA	NA	NA	NA	NA	NA
	MW-27	994663.9	726607.5	470.05	467.4	3/20/2013	NA	NA	NA	NA	NA	NA	NA
	MW-28	995276.3	726639.9	471.18	468.6	3/18/2013	NA	NA	NA	NA	NA	NA	NA
	MW-29	995678.8	726962.2	472.97	470.4	1/30/2014	NA	NA	NA	NA	NA	NA	NA
	MW-30	995759.9	727408.8	472.02	469.3	1/30/2014	NA	NA	NA	NA	NA	NA	NA
	MW-31	995836.2	727853.5	472.51	469.9	2/19/2014	NA	NA	NA	NA	NA	NA	NA
	MW-32	995912.4	728305.6	471.07	468.2	2/19/2014	NA	NA	NA	NA	NA	NA	NA
	MW-33D	995741.5	727408.7	472.15	469.4	3/6/2014	NA	NA	NA	NA	NA	NA	NA
	MW-34D	995560.9	728820.5	470.19	467.4	2/25/2014	NA	NA	NA	NA	NA	NA	NA
	MW-35D	992693.5	727536.2	468.59	465.9	3/8/2014	NA	NA	NA	NA	NA	NA	NA
Other	AW-1	991502.4	733926.6	466.78	463.4	7/19/2014	NA	NA	NA	NA	NA	NA	NA
Nature and Extent Piezometers	TP-1S	997122.3	734100.3	469.08	465.8	6/12/2018	NA	NA	NA	NA	NA	NA	NA
	TP-1M	997122.3	734100.3	469.08	465.8	6/12/2018	NA	NA	NA	NA	NA	NA	NA
	TP-1D	997122.3	734100.3	469.09	465.8	6/12/2018	NA	NA	NA	NA	NA	NA	NA
	TP-2S	993865.6	722603.7	471.24	468.2	6/11/2018	NA	NA	NA	NA	NA	NA	NA
	TP-2M	993865.6	722603.7	471.22	468.2	6/11/2018	NA	NA	NA	NA	NA	NA	NA
	TP-2D	993865.6	722603.7	471.22	468.2	6/11/2018	NA	NA	NA	NA	NA	NA	NA
	TP-3S	996343.6	725783.7	475.60	472.6	6/17/2018	NA	NA	NA	NA	NA	NA	NA
	TP-3M	996343.6	725783.7	475.64	472.6	6/17/2018	NA	NA	NA	NA	NA	NA	NA
	TP-3D	996343.6	725783.7	475.63	472.6	6/17/2018	NA	NA	NA	NA	NA	NA	NA
	TP-4S	999139.8	728578.3	472.07	469.1	6/13/2018	NA	NA	NA	NA	NA	NA	NA
	TP-4M	999139.8	728578.3	472.07	469.1	6/13/2018	NA	NA	NA	NA	NA	NA	NA
	TP-4D	999139.8	728578.3	472.08	469.1	6/13/2018	NA	NA	NA	NA	NA	NA	NA
	TP-5S	999955.0	731876.6	470.39	467.4	6/12/2018	NA	NA	NA	NA	NA	NA	NA
	TP-5M	999955.0	731876.6	470.39	467.4	6/12/2018	NA	NA	NA	NA	NA	NA	NA
	TP-5D	999955.0	731876.6	470.37	467.4	6/12/2018	NA	NA	NA	NA	NA	NA	NA
NPDES[9] Wells	PZ-1S	989647.9	724899.8	470.37	468.1	9/12/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-1D/AMW-1	989663.9	724916.0	470.28	468.1	9/12/2016	NA	NA	NA	NA	NA	NA	NA
	PZ-2S/AMW-2	988727.0	723029.3	489.65	487.4	9/11/2016	NA	NA	NA	NA	NA	NA	NA
	PZ-2D	988721.4	723037.4	490.36	488.0	9/11/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-3S/AMW-3	990485.6	722115.3	482.50	479.9	9/10/2016	NA	NA	NA	NA	NA	NA	NA
	PZ-3D	990502.4	722130.1	481.90	479.6	9/10/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-4S	991552.4	723180.2	488.75	486.3	9/10/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-4D/AMW-4	991567.2	723197.6	488.37	486.2	9/9/2016	NA	NA	NA	NA	NA	NA	NA
	PZ-5S	993066.4	724989.9	492.82	490.5	9/9/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-5D/AMW-5	993079.9	725005.8	492.73	490.8	9/8/2016	NA	NA	NA	NA	NA	NA	NA
	PZ-6S	991133.5	726348.3	468.42	466.0	9/12/2016	7/25/2018	NA	NA	NA	NA	NA	NA
	PZ-6D/AMW-6	991152.7	726348.8	468.35	466.0	9/12/2016	NA	NA	NA	NA	NA	NA	NA
	AMW-7	991996.3	723769.5	491.14	489.1	6/13/2018	NA	NA	NA	NA	NA	NA	NA
	AMW-8	994225.9	726113.0	471.06	468.4	6/13/2018	NA	NA	NA	NA	NA	NA	NA
	AMW-9	993784.5	726717.8	468.93	466.8	6/14/2018	NA	NA	NA	NA	NA	NA	NA
	S1	994676.8	726055.1	472.64	470.4	4/5/2017	NA	NA	NA	NA	NA	NA	NA
	S2	993763.7	726717.6	469.48	467.2	4/5/2017	NA	NA	NA	NA	NA	NA	NA
	S3	992855.4	726692.5	468.97	466.6	4/5/2017	NA	NA	NA	NA	NA	NA	NA
	S4	991859.2	726669.0	468.24	466.0	4/5/2017	NA	NA	NA	NA	NA	NA	NA
River Level	Missouri River	995047.6	723234.9	NA	NA	NA	NA	NA	454.26	NA	464.69	NA	458.15
LCPA Pond	Pond Gauge	990505.0	722506.0	NA	NA	NA	NA	NA	486.25	NA	485.50	NA	485.00

Table 1
Groundwater Elevation Measurements
Labadie Energy Center
Franklin County, Missouri

Groundwater Monitoring Well Program	Well ID	Groundwater Elevation Measurements 9/8/2016		Groundwater Elevation Measurements 11/11/2016		Groundwater Elevation Measurements 1/16/2017		Groundwater Elevation Measurements 3/1/2017		Groundwater Elevation Measurements 5/31/2017		Groundwater Elevation Measurements 11/07/2017		Groundwater Elevation Measurements 1/4/2018	
		DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]
LCPA CCR[8] Wells	UMW-1D	30.90	458.82	32.24	457.48	34.51	455.21	34.72	455.00	22.75	466.97	32.69	457.03	35.40	454.32
	UMW-2D	26.59	458.22	28.14	456.67	30.43	454.38	30.37	454.44	18.08	466.73	28.25	456.56	31.13	453.68
	UMW -3D**	32.82	457.80	34.16	456.46	36.42	454.20	36.52	454.10	24.63	465.99	34.46	456.16	37.20	453.42
	UMW -3D(r)**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	UMW-4D	37.17	457.78	38.42	456.53	40.79	454.16	40.96	453.99	29.23	465.72	39.91	455.04	41.56	453.39
	UMW-5D	38.77	457.99	39.95	456.81	42.31	454.45	42.59	454.17	30.99	465.77	40.60	456.16	43.11	453.65
	UMW-6D	37.90	458.29	39.00	457.19	41.42	454.77	41.78	454.41	30.40	465.79	39.78	456.41	42.18	454.01
	UMW-6D***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	UMW-7D	11.33	458.46	12.25	457.54	14.78	455.01	15.20	454.59	4.07	465.72	13.31	456.48	15.51	454.28
	UMW-8D	10.18	459.29	11.39	458.08	13.84	455.63	14.21	455.26	2.92	466.55	12.30	457.17	14.64	454.83
	UMW-9D	11.32	459.29	12.43	458.18	14.83	455.78	15.15	455.46	3.71	466.90	13.26	457.35	15.66	454.95
	BMW-1D	16.42	457.12	18.36	455.18	20.57	452.97	19.77	453.77	6.65	466.89	17.83	455.71	21.58	451.96
	BMW-2D	16.78	457.61	18.71	455.68	21.16	453.23	20.44	453.95	7.26	467.13	17.72	456.67	21.94	452.45
	AM-1S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AM-1D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LCPB CCR[8] Wells	LMW-1S	11.43	458.63	12.13	457.93	14.75	455.31	15.21	454.85	4.22	465.84	13.46	456.60	15.41	454.65
	LMW-2S	38.54	458.10	39.74	456.90	42.10	454.54	42.42	454.22	30.81	465.83	40.36	456.28	42.84	453.80
	LMW-3S	35.04	457.52	36.24	456.32	38.60	453.96	38.88	453.68	27.08	465.48	36.86	455.70	39.42	453.14
	LMW-4S*	15.44	457.44	16.55	456.33	19.22	453.66	19.45	453.43	7.61	465.27	17.29	455.59	19.80	453.08
	LMW-4S*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	LMW-5S	11.24	457.51	12.13	456.62	14.90	453.85	15.22	453.53	3.59	465.16	13.16	455.59	15.52	453.23
	LMW-6S	11.92	457.64	12.80	456.76	15.40	454.16	15.83	453.73	4.39	465.17	13.83	455.73	16.09	453.47
	LMW-7S	10.64	457.79	11.53	456.90	14.11	454.32	14.50	453.93	3.15	465.28	12.55	455.88	14.84	453.59
	LMW-8S	9.14	458.10	10.00	457.24	12.60	454.64	13.04	454.20	1.88	465.36	11.12	456.12	13.32	453.92
	BMW-1S	16.30	457.19	18.26	455.23	20.53	452.96	19.74	453.75	6.61	466.88	18.31	455.18	21.38	452.11
	BMW-2S	16.83	457.73	18.84	455.72	21.32	453.24	20.64	453.92	7.42	467.14	18.43	456.13	22.04	452.52
LCL1 CCR[8] Wells	TMW-1	11.74	457.60	12.08	457.26	14.94	454.40	15.61	453.73	4.74	464.60	13.77	455.57	15.65	453.69
	TMW-2	13.02	457.38	13.61	456.79	16.51	453.89	17.04	453.36	5.82	464.58	15.18	455.22	17.21	453.19
	TMW-3	12.11	457.30	12.89	456.52	15.54	453.87	16.07	453.34	4.62	464.79	14.12	455.29	16.32	453.09
	MW-26	11.61	457.59	12.46	456.74	15.19	454.01	15.59	453.61	4.17	465.03	13.59	455.61	15.83	453.37
Utility Waste Landfill Wells	MW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-33D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-34D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-35D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other	AW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nature and Extent Piezometers	TP-1S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-1M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-1D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-2S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-2M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-2D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-3S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-3M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-3D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-4S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-4M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-4D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-5S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-5M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	TP-5D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NPDES[9] Wells	PZ-1S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-1D/AMW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-2S/AMW-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-2D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-3S/AMW-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-3D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-4S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-4D/AMW-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-5S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-5D/AMW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-6S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-6D/AMW-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AMW-7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AMW-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AMW-9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Level	Missouri River	NA	453.85	NA	451.84	NA	450.11	NA	451.37	NA	464.22	NA	452.43	NA	447.99
LCPA Pond	Pond Gauge	NA	485.50	NA	485.75	NA	484.75	NA	485.75	NA	485.75	NA	485.20	NA	483.00

Table 1
Groundwater Elevation Measurements
Labadie Energy Center
Franklin County, Missouri

Groundwater Monitoring Well Program	Well ID	Groundwater Elevation Measurements 3/5/2018		Groundwater Elevation Measurements 4/9/2018		Groundwater Elevation Measurements 5/21/2018		Groundwater Elevation Measurements 6/25/2018		Groundwater Elevation Measurements 7/24/2018		Groundwater Elevation Measurements 8/22/2018		Groundwater Elevation Measurements 9/27/2018	
		DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]
LCPA CCR[8] Wells	UMW-1D	33.88	455.84	31.57	458.15	31.29	458.43	30.95	458.77	29.70	460.02	31.35	458.37	29.89	459.83
	UMW-2D	29.17	455.64	27.07	457.74	26.79	458.02	26.35	458.46	25.01	459.80	26.80	458.01	25.21	459.60
	UMW -3D**	35.29	455.33	33.41	457.21	33.01	457.61	32.47	458.15	32.53	458.09	34.21	456.41	NA	NA
	UMW -3D(r)**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	UMW-4D	39.99	454.96	38.09	456.86	37.57	457.38	36.94	458.01	35.92	459.03	37.55	457.40	36.02	458.93
	UMW-5D	41.86	454.90	39.80	456.96	39.28	457.48	38.67	458.09	37.66	459.10	39.27	457.49	37.80	458.96
	UMW-6D	41.12	455.07	39.06	457.13	38.54	457.65	37.95	458.24	37.04	459.15	38.59	457.60	37.19	459.00
	UMW-6D***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	UMW-7D	14.79	455.00	12.61	457.18	12.01	457.78	11.45	458.34	10.71	459.08	12.11	457.68	10.86	458.93
	UMW-8D	13.64	455.83	11.48	457.99	11.02	458.45	10.54	458.93	10.58	458.89	11.07	458.40	9.77	459.70
	UMW-9D	14.45	456.16	12.24	458.37	11.82	458.79	11.46	459.15	10.43	460.18	12.00	458.61	10.63	459.98
	BMW-1D	17.38	456.16	15.89	457.65	15.55	457.99	15.20	458.34	13.20	460.34	15.95	457.59	13.89	459.65
	BMW-2D	18.41	455.98	16.65	457.74	16.46	457.93	16.19	458.20	NA	NA	16.61	457.78	14.68	459.71
	AM-1S	NA	NA	NA	NA	NA	NA	25.94	457.06	25.03	457.97	27.31	455.69	25.11	457.89
	AM-1D	NA	NA	NA	NA	NA	NA	25.81	456.97	24.80	457.98	27.02	455.76	24.86	457.92
LCPB CCR[8] Wells	LMW-1S	15.21	454.85	12.83	457.23	12.24	457.82	11.63	458.43	11.07	458.99	12.37	457.69	11.14	458.92
	LMW-2S	41.56	455.08	39.64	457.00	39.12	457.52	38.49	458.15	37.51	459.13	39.09	457.55	37.64	459.00
	LMW-3S	37.43	455.13	36.06	456.50	35.51	457.05	34.84	457.72	33.81	458.75	35.47	457.09	33.97	458.59
	LMW-4S*	19.03	453.85	16.83	456.05	16.32	456.56	15.68	457.20	NA	NA	NA	NA	NA	NA
	LMW-4S*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	LMW-5S	15.06	453.69	12.81	455.94	12.24	456.51	13.45	455.30	10.44	458.31	11.80	456.95	10.63	458.12
	LMW-6S	15.63	453.93	13.41	456.15	12.79	456.77	12.06	457.50	11.14	458.42	12.56	457.00	11.33	458.23
	LMW-7S	14.14	454.29	11.94	456.49	11.31	457.12	10.70	457.73	9.87	458.56	11.28	457.15	11.02	457.41
	LMW-8S	12.66	454.58	10.46	456.78	9.83	457.41	9.23	458.01	8.49	458.75	9.92	457.32	8.69	458.55
	BMW-1S	17.28	456.21	15.82	457.67	15.54	457.95	15.24	458.25	13.69	459.80	15.91	457.58	13.86	459.63
	BMW-2S	18.62	455.94	16.81	457.75	16.67	457.89	16.42	458.14	14.61	459.95	16.69	457.87	14.81	459.75
LCL1 CCR[8] Wells	TMW-1	16.12	453.22	14.06	455.28	13.24	456.10	12.31	457.03	11.62	457.72	12.64	456.70	11.73	457.61
	TMW-2	17.35	453.05	15.24	455.16	14.35	456.05	13.47	456.93	12.78	457.62	13.86	456.54	13.02	457.38
	TMW-3	16.04	453.37	13.95	455.46	13.13	456.28	13.30	456.11	11.55	457.86	12.81	456.60	11.77	457.64
	MW-26	15.52	453.68	13.28	455.92	12.65	456.55	11.82	457.38	10.99	458.21	12.29	456.91	11.10	458.10
Utility Waste Landfill Wells	MW-1	NA	NA	NA	NA	NA	NA	NA	NA	14.18	457.87	15.65	456.40	14.35	457.70
	MW-2	NA	NA	NA	NA	NA	NA	NA	NA	14.08	457.78	15.42	456.44	14.25	457.61
	MW-3	NA	NA	NA	NA	NA	NA	NA	NA	13.28	457.73	14.53	456.48	13.54	457.47
	MW-4	18.18	452.78	NA	NA	NA	NA	NA	NA	13.32	457.64	14.53	456.43	13.58	457.38
	MW-5	17.31	452.75	NA	NA	NA	NA	13.26	456.80	12.43	457.63	13.53	456.53	12.67	457.39
	MW-6	NA	NA	NA	NA	NA	NA	NA	NA	12.01	457.67	13.12	456.56	12.32	457.36
	MW-7	NA	NA	NA	NA	NA	NA	NA	NA	11.59	457.56	12.63	456.52	11.77	457.38
	MW-8	15.34	452.91	NA	NA	NA	NA	11.30	456.95	10.76	457.49	11.74	456.51	10.93	457.32
	MW-9	14.88	452.93	NA	NA	NA	NA	NA	NA	10.34	457.47	11.31	456.50	10.51	457.30
	MW-10	15.54	453.02	NA	NA	NA	NA	NA	NA	11.14	457.42	12.15	456.41	11.31	457.25
	MW-11	15.53	453.02	NA	NA	NA	NA	11.62	456.93	11.18	457.37	12.15	456.40	11.34	457.21
	MW-12	15.05	453.06	NA	NA	NA	NA	NA	NA	10.78	457.33	11.73	456.38	10.96	457.15
	MW-13	15.01	453.09	NA	NA	NA	NA	NA	NA	10.81	457.29	11.75	456.35	10.98	457.12
	MW-14	13.77	453.06	NA	NA	NA	NA	9.84	456.99	9.69	457.14	10.58	456.25	9.83	457.00
	MW-15	14.14	453.16	NA	NA	NA	NA	NA	NA	10.10	457.20	11.07	456.23	10.26	457.04
	MW-16	NA	NA	NA	NA	NA	NA	NA	NA	9.63	456.94	10.56	456.01	9.76	456.81
	MW-17	14.54	453.35	NA	NA	NA	NA	10.58	457.31	10.78	457.11	11.73	456.16	10.96	456.93
	MW-18	6.77	458.50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.85	456.42
	MW-19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.79	457.37
	MW-20	12.15	453.82	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.61	457.36
	MW-21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MW-22	12.47	454.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.66	458.14
	MW-23	6.30	461.24	NA	NA	NA	NA	NA	NA	10.04	457.50	12.49	455.05	11.77	455.77
	MW-24	NA	NA	NA	NA	NA	NA	NA	NA	9.05	458.05	10.30	456.80	9.06	458.04
	MW-25	14.81	453.80	NA	NA	NA	NA	11.06	457.55	10.49	458.12	11.76	456.85	10.50	458.11
	MW-27	16.46	453.59	NA	NA	NA	NA	NA	NA	11.86	458.19	13.31	456.74	12.02	458.03
	MW-28	18.60	452.58	NA	NA	NA	NA	13.66	457.52	13.05	458.13	14.63	456.55	13.31	457.87
	MW-29	19.57	453.40	NA	NA	NA	NA	NA	NA	15.09	457.88	16.64	456.33	15.21	457.76
	MW-30	18.70	453.32	NA	NA	NA	NA	15.13	456.89	14.02	458.00	15.63	456.39	14.35	457.67
	MW-31	19.41	453.10	NA	NA	NA	NA	NA	NA	14.77	457.74	16.09	456.42	14.97	457.54
	MW-32	18.26	452.81	NA	NA	NA	NA	14.35	456.72	13.36	457.71	14.59	456.48	13.63	457.44
	MW-33D	18.68	453.47	NA	NA	NA	NA	15.26	456.89	14.32	457.83	15.79	456.36	14.47	457.68
	MW-34D	17.13	453.06	NA	NA	NA	NA	13.31	456.88	12.58	457.61	13.80	456.39	12.78	457.41
	MW-35D	14.77	453.82	NA	NA	NA	NA	11.03	457.56	10.44	458.15	11.75	456.84	10.46	458.13
Other	AW-1	6.93	459.85	NA	NA	NA	NA	6.81	459.97	NA	NA	11.56	455.22	10.41	456.37
Nature and Extent Piezometers	TP-1S	NA	NA	NA	NA	NA	NA	13.04	456.04	12.54	456.54	13.61	455.47	12.90	456.18
	TP-1M	NA	NA	NA	NA	NA	NA	13.05	456.03	12.60	456.48	13.62	455.46	12.87	456.21
	TP-1D	NA	NA	NA	NA	NA	NA	13.04	456.05	12.56	456.53	13.64	455.45	12.86	456.23
	TP-2S	NA	NA	NA	NA	NA	NA	13.96	457.28	12.86	458.38	14.70	456.54	12.81	458.43
	TP-2M	NA	NA	NA	NA	NA	NA	13.64	457.58	12.83	458.39	14.51	456.71	12.66	458.56
	TP-2D	NA	NA	NA	NA	NA	NA	13.63	457.59	12.82	458.40	14.50	456.72	12.64	458.58
	TP-3S	NA	NA	NA	NA	NA	NA	19.28	456.32	17.96	457.64	20.04	455.56	18.12	457.48
	TP-3M	NA	NA	NA	NA	NA	NA	19.18	456.46	18.04	457.60	20.13	455.51	18.19	457.45
	TP-3D	NA	NA	NA	NA	NA	NA	19.10	456.53	18.02	457.61	20.10	455.53	18.16	457.47
	TP-4S	NA	NA	NA	NA	NA	NA	16.07	456.00	15.26	456.81	17.46	454.61	15.48	456.59
	TP-4M	NA	NA	NA	NA	NA	NA	16.02	456.05	15.25	456.82	17.46	454.61	15.47	456.60
	TP-4D	NA	NA	NA	NA	NA	NA	16.03	456.05	15.27	456.81	17.47	454.61	15.47	456.61
	TP-5S	NA	NA	NA	NA	NA	NA	14.93	455.46	13.82	456.57	15.57	454.82	14.26	456.13
	TP-5M	NA	NA	NA	NA	NA	NA	14.91	455.48	13.84	456.55	15.60	454.79	14.16	456.23
	TP-5D	NA	NA	NA	NA	NA	NA	14.85	455.52	13.81	456.56	15.55	454.82	14.11	456.26
NPDES[9] Wells	PZ-1S	NA	NA	NA	NA	NA	NA	11.14	459.23	10.27	460.10	NA	NA	NA	NA
	PZ-1D/AMW-1	NA	NA	NA	NA	NA	NA	11.24	459.04	10.12	460.16	11.67	458.61	10.26	460.02
	PZ-2S/AMW-2	NA	NA	NA	NA	NA	NA	30.69	458.96	29.46	460.19	31.13	458.52	29.60	460.05
	PZ-2D	NA	NA	NA	NA	NA	NA	30.46	459.90	30.19	460.17	NA	NA	NA	NA
	PZ-3S/AMW-3	NA	NA	NA	NA	NA	NA	24.04	458.46	NA	NA	24.49	458.01	22.80	459.70
	PZ-3D	NA	NA	NA	NA	NA	NA	23.46	458.44	NA	NA	NA	NA	NA	NA
	PZ-4S	NA	NA	NA	NA	NA	NA	30.32	458.43	NA	NA	NA	NA	NA	NA
	PZ-4D/AMW-4	NA	NA	NA	NA	NA	NA	29.99	458.38	28.78	459.59	30.51	457.86	28.88	459.49
	PZ-5S	NA	NA	NA	NA	NA	NA	34.99	457.83	NA	NA	NA	NA	NA	NA
	PZ-5D/AMW-5	NA	NA	NA	NA	NA	NA	34.88	457.85	33.89	458.84	35.51	457.22	33.91	458.82
	PZ-6S	NA	NA	NA	NA	NA	NA	10.25	458.17	9.54	458.88	NA	NA	NA	NA
	PZ-6D/AMW-6	NA	NA	NA	NA	NA	NA	10.19	458.16	9.48	458.87	10.87	457.48	9.57	458.78
	AMW-7	NA	NA	NA	NA	NA	NA	NA	NA	31.34	459.80	NA	NA	31.94	459.20
	AMW-8	NA	NA	NA	NA	NA	NA	NA	NA	12.71	458.35	14.26	456.80	12.76	458.30
	AMW-9	NA	NA	NA	NA	NA	NA	11.52	457.41	10.68	458.25	12.10	456.83	10.80	458.13
	S1	NA	NA	NA	NA	NA	NA	15.45	457.19	14.29	458.35	15.71	456.93	14.45	458.19
	S2	NA	NA	NA	NA	NA	NA	11.99	457.49	11.11	458.37	12.47	457.01	11.27	458.21
	S3	NA	NA	NA	NA	NA	NA	11.29	457.68	10.52	458.45	11.91	457.06	10.65	458.32
	S4	NA	NA	NA	NA	NA	NA	10.29	457.95	9.67	458.57	11.06	457.18	9.74	458.50
River Level	Missouri River	NA	454.50	NA	455.31	NA	456.64	NA	457.20	NA	457.59	NA	455.19	NA	457.62
LCPA Pond	Pond Gauge	NA	483.50	NA	485.50	NA	485.20	NA	486.00	NA	484.20	NA	484.50	NA	485.20

Table 1
Groundwater Elevation Measurements
Labadie Energy Center
Franklin County, Missouri

Groundwater Monitoring Well Program	Well ID	Groundwater Elevation Measurements 11/7/2018		Groundwater Elevation Measurements 1/2/2019		Groundwater Elevation Measurements 4/23/2019		Groundwater Elevation Measurements 4/29/2019		Groundwater Elevation Measurements 10/4/2019	
		DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]	DTW[1]	GWE[2]
LCPA CCR[8] Wells	UMW-1D	27.80	461.92	26.03	463.69	23.61	466.11	23.89	465.83	22.09	467.63
	UMW-2D	23.13	461.68	20.87	463.94	19.05	465.76	19.29	465.52	16.95	467.86
	UMW -3D**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	UMW -3D(r)**	29.81	461.32	27.60	463.53	25.67	465.46	25.93	465.20	23.90	467.23
	UMW-4D	33.96	460.99	32.13	462.82	29.71	465.24	29.93	465.02	28.37	466.58
	UMW-5D	35.70	461.06	34.12	462.64	31.44	465.32	31.69	465.07	30.45	466.31
	UMW-6D	35.03	461.16	33.49	462.70	29.84	466.35	31.08	465.11	NA	NA
	UMW-6D***	NA	NA	NA	NA	NA	NA	NA	NA	25.52	466.99
	UMW-7D	8.51	461.28	7.38	462.41	4.43	465.36	4.62	465.17	4.14	465.65
	UMW-8D	7.55	461.92	6.35	463.12	3.47	466.00	3.62	465.85	3.04	466.43
	UMW-9D	8.51	462.10	6.95	463.66	4.35	466.26	4.56	466.05	3.64	466.97
	BMW-1D	12.14	461.40	9.37	464.17	7.74	465.80	7.72	465.82	4.45	469.09
	BMW-2D	12.98	461.41	11.57	462.82	8.03	466.36	8.28	466.11	5.74	468.65
	AM-1S	23.28	459.72	18.61	464.39	19.19	463.81	19.40	463.60	15.04	467.96
	AM-1D	23.06	459.72	18.54	464.24	18.86	463.92	19.09	463.69	15.10	467.68
LCPB CCR[8] Wells	LMW-1S	8.56	461.50	7.72	462.34	NA	NA	4.62	465.44	4.78	465.28
	LMW-2S	35.54	461.10	33.94	462.70	NA	NA	31.53	465.11	30.37	466.27
	LMW-3S	31.86	460.70	30.15	462.41	NA	NA	27.73	464.83	NA	NA
	LMW-4S*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	LMW-4S*	12.36	460.47	11.62	461.21	NA	NA	8.11	464.72	7.17	465.66
	LMW-5S	8.42	460.33	7.90	460.85	NA	NA	4.15	464.60	3.37	465.38
	LMW-6S	9.09	460.47	8.17	461.39	NA	NA	5.91	463.65	4.24	465.32
	LMW-7S	7.72	460.71	6.55	461.88	NA	NA	3.71	464.72	3.03	465.40
	LMW-8S	6.29	460.95	5.21	462.03	NA	NA	2.40	464.84	1.94	465.30
	BMW-1S	12.18	461.31	9.45	464.04	7.41	466.08	7.70	465.79	4.50	468.99
	BMW-2S	13.10	461.46	12.13	462.43	8.09	466.47	8.41	466.15	5.92	468.64
LCL1 CCR[8] Wells	TMW-1	9.46	459.88	8.75	460.59	NA	NA	5.01	464.33	5.38	463.96
	TMW-2	10.84	459.56	10.28	460.12	NA	NA	6.08	464.32	6.41	463.99
	TMW-3	9.56	459.85	8.82	460.59	NA	NA	4.98	464.43	4.85	464.56
	MW-26	8.85	460.35	8.29	460.91	NA	NA	4.61	464.59	4.12	465.08
Utility Waste Landfill Wells	MW-1	12.40	459.65	11.35	460.70	NA	NA	7.39	464.66	7.05	465.00
	MW-2	12.32	459.54	11.54	460.32	NA	NA	7.04	464.82	7.17	464.69
	MW-3	11.56	459.45	11.16	459.85	NA	NA	7.43	463.58	6.59	464.42
	MW-4	11.81	459.15	11.42	459.54	NA	NA	6.41	464.55	6.76	464.20
	MW-5	10.74	459.32	10.37	459.69	NA	NA	5.58	464.48	6.04	464.02
	MW-6	10.37	459.31	9.95	459.73	NA	NA	5.31	464.37	5.86	463.82
	MW-7	9.78	459.37	9.19	459.96	NA	NA	4.89	464.26	5.43	463.72
	MW-8	8.90	459.35	8.25	460.00	NA	NA	4.06	464.19	4.66	463.59
	MW-9	8.48	459.33	7.79	460.02	NA	NA	3.68	464.13	4.31	463.50
	MW-10	9.25	459.31	8.60	459.96	NA	NA	4.51	464.05	5.12	463.44
	MW-11	9.28	459.27	8.62	459.93	NA	NA	4.06	464.49	5.23	463.32
	MW-12	8.89	459.22	8.17	459.94	NA	NA	4.23	463.88	4.93	463.18
	MW-13	9.91	458.19	8.13	459.97	NA	NA	4.32	463.78	5.05	463.05
	MW-14	7.72	459.11	6.91	459.92	NA	NA	3.21	463.62	3.97	462.86
	MW-15	8.14	459.16	7.27	460.03	NA	NA	3.81	463.49	4.50	462.80
	MW-16	7.31	459.26	6.46	460.11	NA	NA	3.57	463.00	4.03	462.54
	MW-17	8.83	459.06	7.68	460.21	NA	NA	4.55	463.34	5.33	462.56
	MW-18	4.37	460.90	NA	NA	NA	NA	2.43	462.84	2.87	462.40
	MW-19	6.15	460.01	NA	NA	NA	NA	2.65	463.51	NA	NA
	MW-20	6.02	459.95	NA	NA	NA	NA	2.45	463.52	NA	NA
	MW-21	5.44	460.46	NA	NA	NA	NA	2.71	463.19	NA	NA
	MW-22	6.62	460.18	NA	NA	NA	NA	2.95	463.85	NA	NA
	MW-23	7.42	460.12	NA	NA	NA	NA	3.95	463.59	5.58	461.96
	MW-24	6.81	460.29	NA	NA	NA	NA	2.83	464.27	2.85	464.25
	MW-25	8.21	460.40	NA	NA	NA	NA	4.20	464.41	3.95	464.66
	MW-27	9.87	460.18	9.96	460.09	NA	NA	5.22	464.83	4.84	465.21
	MW-28	11.36	459.82	10.71	460.47	NA	NA	5.84	465.34	6.50	464.68
	MW-29	13.29	459.68	12.09	460.88	NA	NA	8.31	464.66	7.79	465.18
	MW-30	12.44	459.58	11.50	460.52	NA	NA	7.38	464.64	7.13	464.89
	MW-31	13.04	459.47	12.47	460.04	NA	NA	7.96	464.55	7.92	464.59
	MW-32	11.69	459.38	11.61	459.46	NA	NA	6.50	464.57	6.76	464.31
	MW-33D	12.50	459.65	11.49	460.66	NA	NA	7.69	464.46	7.11	465.04
	MW-34D	10.78	459.41	10.19	460.00	NA	NA	5.93	464.26	6.02	464.17
	MW-35D	8.22	460.37	NA	NA	NA	NA	4.14	464.45	3.83	464.76
Other	AW-1	6.75	460.03	NA	NA	NA	NA	3.86	462.92	4.12	462.66
Nature and Extent Piezometers	TP-1S	10.97	458.11	10.17	458.91	NA	NA	5.02	464.06	6.81	462.27
	TP-1M	10.96	458.12	10.18	458.90	NA	NA	5.09	463.99	6.80	462.28
	TP-1D	10.95	458.14	10.19	458.90	NA	NA	6.07	463.02	6.79	462.30
	TP-2S	10.82	460.42	7.12	464.12	NA	NA	6.98	464.26	3.22	468.02
	TP-2M	10.72	460.50	7.12	464.10	NA	NA	7.81	463.41	3.67	467.55
	TP-2D	10.71	460.51	7.12	464.10	NA	NA	7.86	463.36	3.68	467.54
	TP-3S	16.20	459.40	12.91	462.69	NA	NA	11.80	463.80	8.95	466.65
	TP-3M	16.17	459.47	12.80	462.84	NA	NA	11.90	463.74	8.89	466.75
	TP-3D	16.21	459.42	12.87	462.76	NA	NA	11.91	463.72	8.85	466.78
	TP-4S	13.65	458.42	9.43	462.64	8.89	463.18	9.25	462.82	NA	NA
	TP-4M	13.61	458.46	9.40	462.67	9.04	463.03	9.26	462.81	NA	NA
	TP-4D	13.62	458.46	9.39	462.69	9.11	462.97	9.29	462.79	NA	NA
	TP-5S	12.37	458.02	10.50	459.89	NA	NA	7.38	463.01	5.97	464.42
	TP-5M	12.37	458.02	10.35	460.04	NA	NA	7.41	462.98	5.88	464.51
	TP-5D	12.33	458.04	10.40	459.97	NA	NA	7.37	463.00	5.94	464.43
NPDES[9] Wells	PZ-1S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-1D/AMW-1	8.16	462.12	6.77	463.51	NA	NA	4.24	466.04	3.46	466.82
	PZ-2S/AMW-2	27.60	462.05	25.75	463.90	NA	NA	23.57	466.08	21.80	467.85
	PZ-2D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-3S/AMW-3	20.75	461.75	18.39	464.11	NA	NA	16.92	465.58	NA	NA
	PZ-3D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-4S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-4D/AMW-4	26.86	461.51	24.55	463.82	NA	NA	23.41	464.96	20.85	467.52
	PZ-5S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-5D/AMW-5	31.93	460.80	30.10	462.63	NA	NA	27.84	464.89	NA	NA
	PZ-6S	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PZ-6D/AMW-6	7.23	461.12	6.16	462.19	NA	NA	3.39	464.96	2.94	465.41
	AMW-7	29.91	461.23	27.69	463.45	NA	NA	26.01	465.13	23.86	467.28
	AMW-8	10.73	460.33	9.96	461.10	NA	NA	6.53	464.53	5.51	465.55
	AMW-9	8.61	460.32	7.59	461.34	NA	NA	4.36	464.57	3.73	465.20
	S1	12.30	460.34	11.74	460.90	NA	NA	7.70	464.94	NA	NA
	S2	9.04	460.44	8.41	461.07	NA	NA	4.81	464.67	4.34	465.14
	S3	8.37	460.60	7.40	461.57	NA	NA	4.24	464.73	3.72	465.25
	S4	7.38	460.86	6.36	461.88	NA	NA	3.41	464.83	3.02	465.22
River Level	Missouri River	NA	459.40	NA	465.62	NA	463.29	NA	463.14	NA	468.67
LCPA Pond	Pond Gauge	NA	482.00	NA	485.50	NA	BG	NA	BG	NA	BG

Table 1
Groundwater Elevation Measurements
Labadie Energy Center
Franklin County, Missouri

Notes:
1.) DTW - Depth to water measured in feet below top of casing.
2.) GWE - Groundwater elevation measured in feet above mean sea level.
3.) Feet MSL - Feet above mean sea level.
4.) Horizontal Datum: State Plane Coordinates NAD83 (2000) Missouri East Zone feet.
5.) Vertical Datum: NAVD88 feet.
6.) NA - Not Applicable.
7.) Missouri River level obtained from United States Geological Survey (USGS) gauge 06935550.
8.) CCR - Coal Combustion Residuals.
9.) NPDES - National Pollutant Discharge Elimination System.
10.) * - LMW-4S was hit by a piece of equipment. The protective cover and riser pipe were replaced on October 26, 2018.
11.) ** - UMW-3D was hit by a piece of equipment which comprimised the integrity of the well. The well was reintstalled as UMW-3D(r) on October 26, 2018.
12.) *** - UMW-6D was modified due to CCR unit closure activites.
13.) BG - Below Gauge. Pond water level was too far below gauge to estimate elevation.

Prepared By: KAB
Checked By: AMM
Reviewed By: CMR

Table 2
Generalized Hydraulic Properties of Uppermost Aquifer
Labadie Energy Center
Franklin County, Missouri

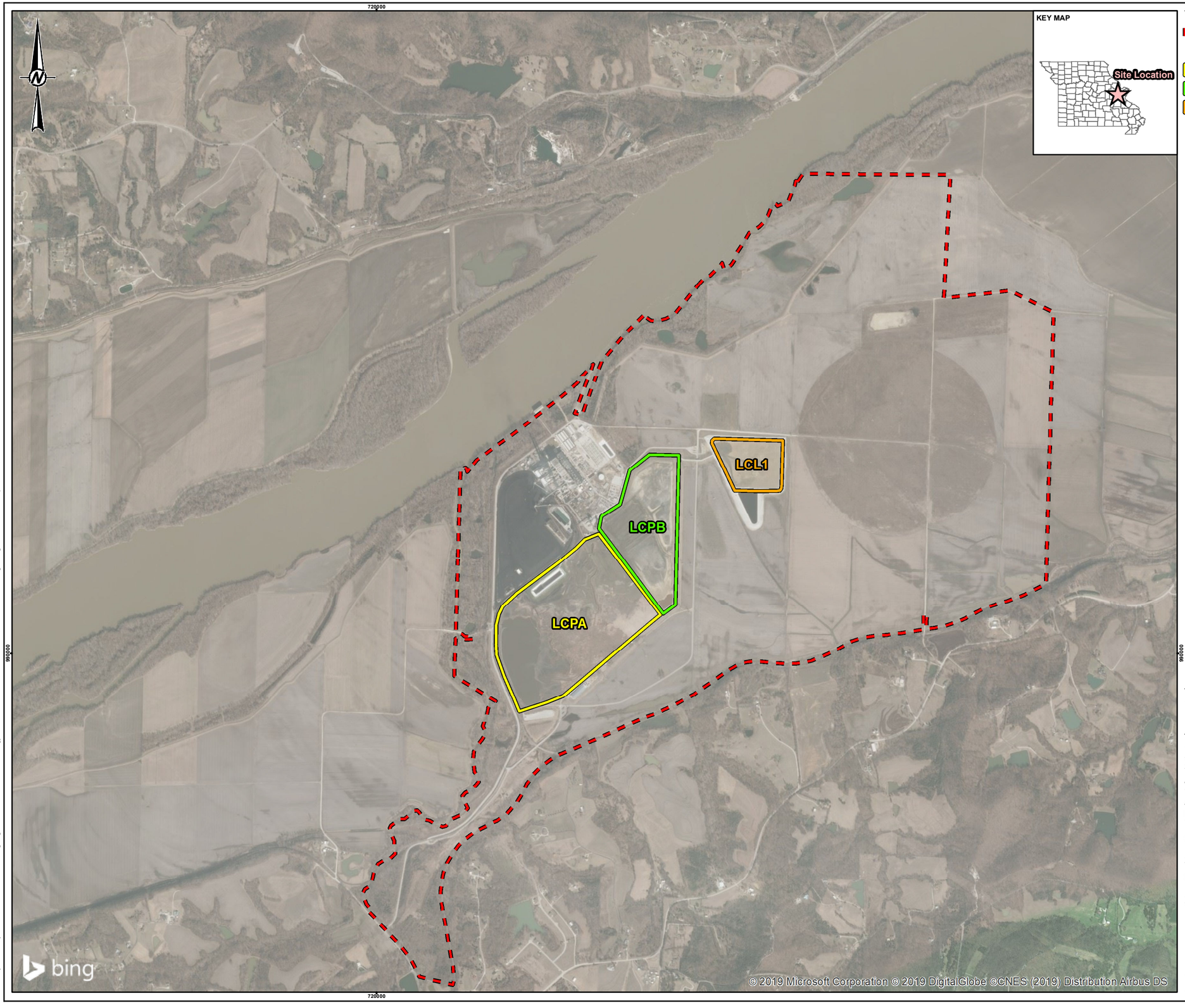
Baseline Sampling Event Date	Average Groundwater flow Direction (Azimuth)	Estimated Hydraulic Gradient (Feet/Foot)	Hydraulic Conductivity (Feet/Day)	Mean Hydraulic Conductivity (cm/sec)	Estimated Effective Porosity	Estimated Groundwater Velocity (Feet/Day)
3/22/2016	331	0.00040	58.33	2.1E-02	0.35	0.07
5/3/2016	52	0.00059	58.33	2.1E-02	0.35	0.10
7/11/2016	13	0.00031	58.33	2.1E-02	0.35	0.05
9/8/2016	345	0.00039	58.33	2.1E-02	0.35	0.06
11/11/2016	325	0.00050	58.33	2.1E-02	0.35	0.08
1/16/2017	336	0.00047	58.33	2.1E-02	0.35	0.08
3/1/2017	350	0.00039	58.33	2.1E-02	0.35	0.06
5/31/2017	41	0.00031	58.33	2.1E-02	0.35	0.05
11/7/2017	353	0.00037	58.33	2.1E-02	0.35	0.06
1/4/2018	334	0.00045	58.33	2.1E-02	0.35	0.07
3/5/2018	354	0.00063	58.33	2.1E-02	0.35	0.11
4/9/2018	26	0.00042	58.33	2.1E-02	0.35	0.07
5/21/2018	15	0.00038	58.33	2.1E-02	0.35	0.06
6/25/2018	2	0.00033	58.33	2.1E-02	0.35	0.06
7/24/2018	44	0.00026	58.33	2.1E-02	0.35	0.04
8/22/2018	20	0.00027	58.33	2.1E-02	0.35	0.05
9/27/2018	55	0.00028	58.33	2.1E-02	0.35	0.05
11/7/2018	33	0.00032	58.33	2.1E-02	0.35	0.05
1/2/2019	91	0.00047	58.33	2.1E-02	0.35	0.08
4/29/2019	47	0.00018	58.33	2.1E-02	0.35	0.03
10/4/2019	100	0.00057	58.33	2.1E-02	0.35	0.09

Estimated Results	
Resultant Groundwater Flow Direction (Azimuth)	24
Estimated Annual Net Groundwater Movement (Feet/Year)	17

Prepared By: KAB
Checked By: AMM
Reviewed By: MNH

Notes:
1. Azimuth and Hydraulic Gradient calculated using the spreadsheet tool from the 2005 report entitled "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water" by J.F. Devlin
2. Hydraulic conductivity value is the geometric mean of slug test results for the CCR compliance wells.
3. An effective porosity of 0.35 was used based on grain size distributions and published values (Fetter 2000, Cohen 1953, and Johnson 1967).
4. Azimuth is measured clockwise in degrees from north.
5. cm/sec - centimeters per second.
6. Water level elevations used are provide in Table 1 of this report.

Figures



LEGEND

Approximate Property Boundary

Labadie Energy Center CCR Units

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment
- LCL1 - Utility Waste Landfill Cell 1

0 1,000 2,000 3,000 4,000 5,000 6,000

Feet

1 " = 2,000 feet

NOTE(S)

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.

REFERENCE(S)

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2019-10-25
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BCW
APPROVED	MNH

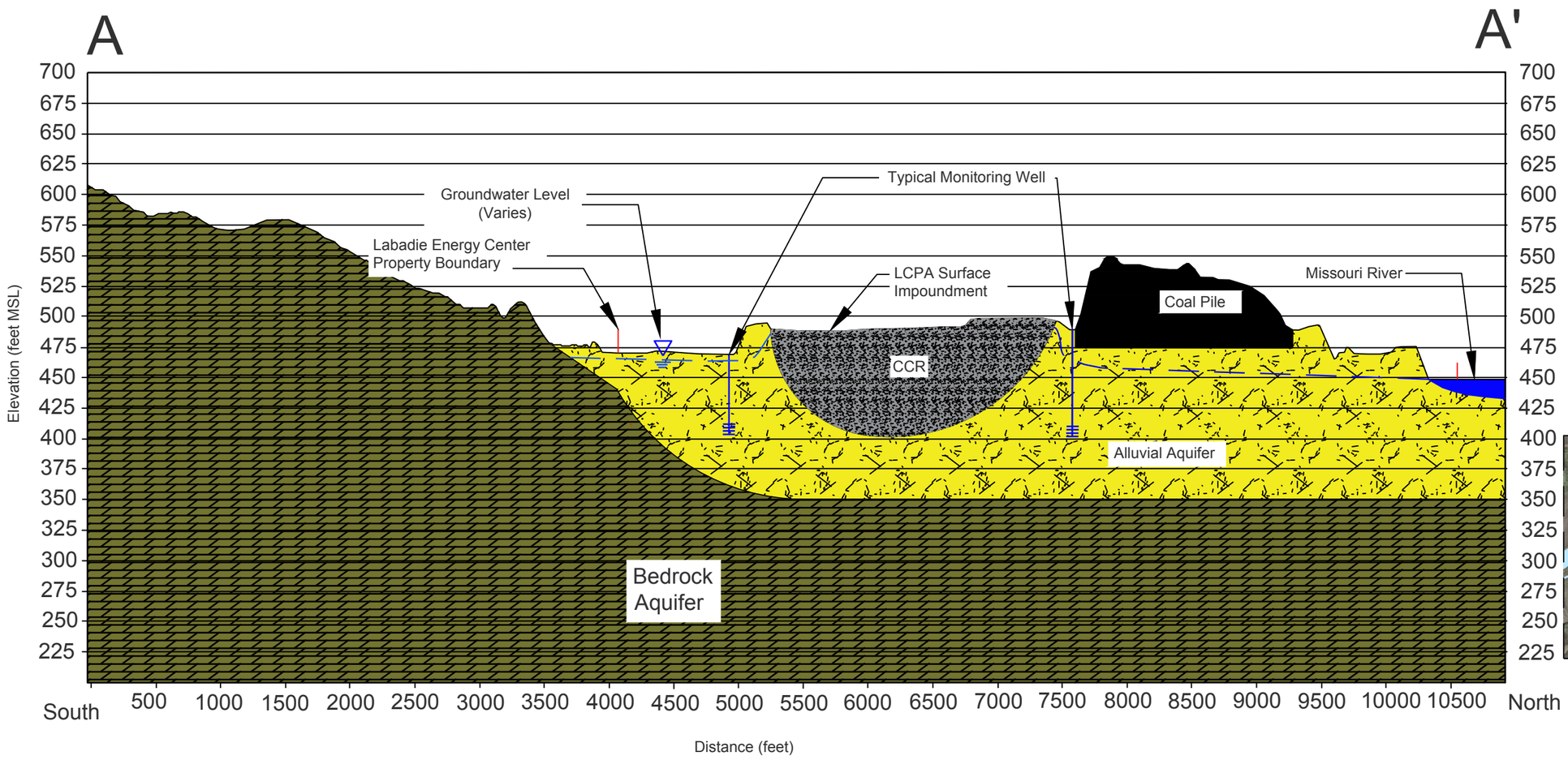
PROJECT NO.	CONTROL	REV.	FIGURE
153140602	1240	0.0	1

AMEREN_00002683

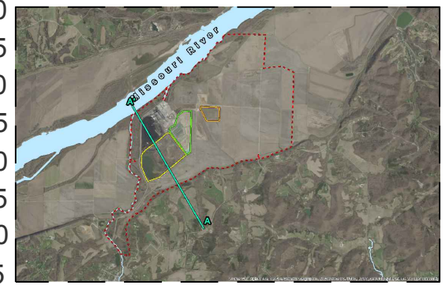
PATH: G:\Projects\153\Projects\153140602 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\2019-10-25 - CA GMP Figures\Figure 1 - Site Location Map.mxd PRINTED ON: 2019-11-06 AT: 8:15:12 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Generalized Cross-Section



Overview Map



NOT TO SCALE

NOTES
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) CROSS-SECTION IS NOT TO SCALE AND IS ONLY A VISUAL REPRESENTATION OF THE SUBSURFACE GEOLOGY AND FEATURES.
3.) MSL - MEAN SEA LEVEL.

REFERENCES
1.) AMEREN, 2011. AMEREN MISSOURI LABADIE ENERGY CENTER, LABADIE PROPERTY CONTROL MAP, NOVEMBER 2011
2.) GREDELL ENGINEERING RESOURCES, INC., AND REITZ & JENS. 2011. DETAILED SITE INVESTIGATION REPORT FOR: AMEREN MISSOURI LABADIE POWER PLANT PROPOSED UTILITY WASTE DISPOSAL AREA FRANKLIN COUNTY, MISSOURI.
3.) GOLDER 2017, GROUNDWATER MONITORING PLAN, LCPA.

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

CONSULTANT
GOLDER

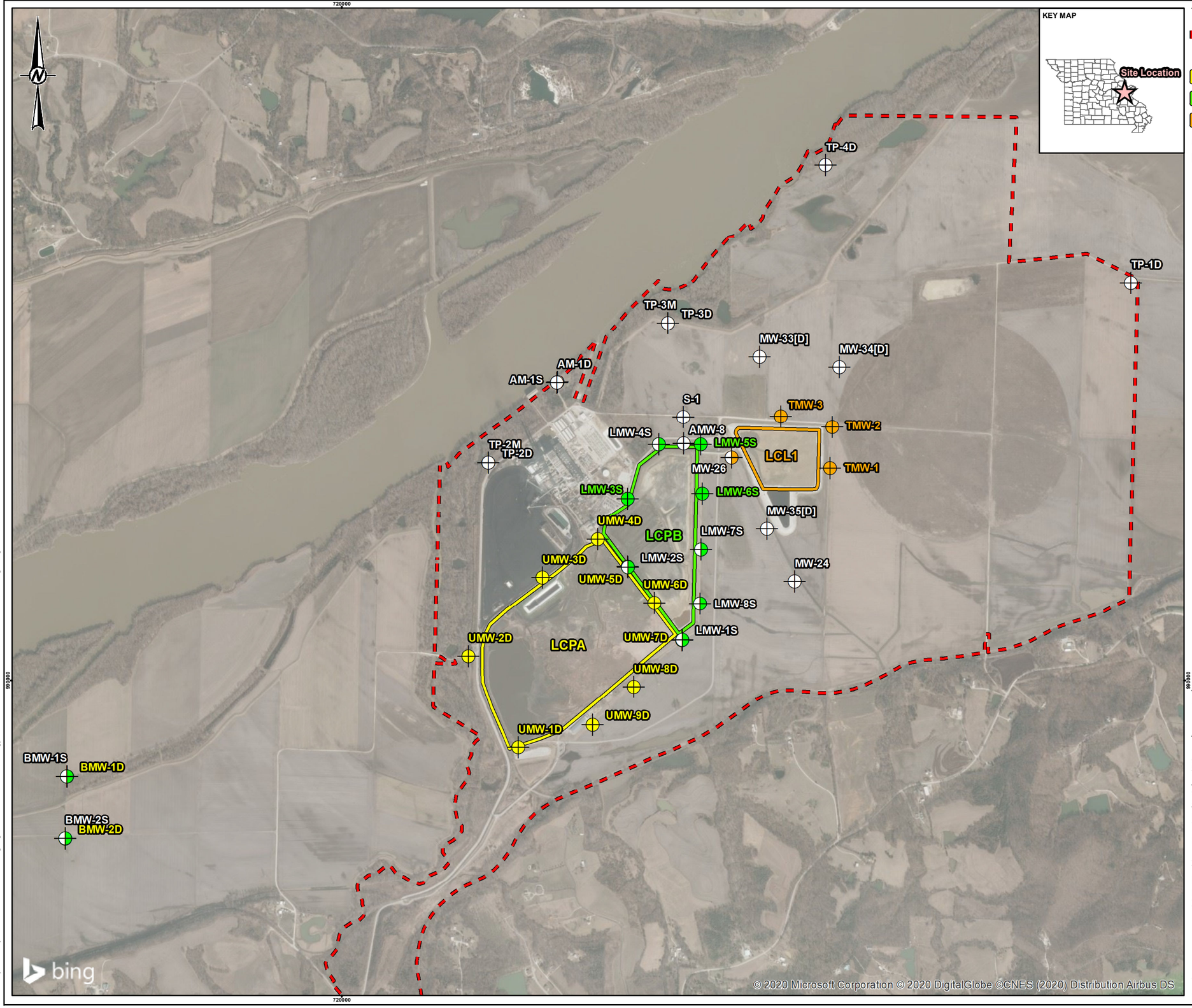
YYYY-MM-DD	2019-10-25
DESIGNED	JSI
PREPARED	BCW
REVIEWED	JSI
APPROVED	MNH

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
GENERALIZED CROSS-SECTION

PROJECT NO.	PHASE	REV.	FIGURE
153140602	0001	0.0	2

AMEREN_00002684



LEGEND

Approximate Property Boundary

Labadie Energy Center CCR Units

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment
- LCL1 - Utility Waste Landfill Cell 1

Groundwater Monitoring Wells Used for LCPA CCR Rule Monitoring

- LCPA Detection/Assessment Monitoring Well Network
- LCPA Corrective Action Monitoring Well Network
- LCPB Detection and LCPA Corrective Action Monitoring Well Networks
- LCPB Detection Monitoring Well Network
- LCL1 Detection and LCPA Corrective Action Monitoring Well Networks
- LCL1 Detection Monitoring Well Network

0 1,000 2,000 3,000 4,000

Feet

NOTE(S)

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.

REFERENCE(S)

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
LABADIE ENERGY CENTER GROUNDWATER MONITORING PROGRAM MONITORING WELL LOCATION MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2020-04-23
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BTT
APPROVED	CMR

PROJECT NO.	CONTROL	REV.	FIGURE
153140602	1240	1	4

AMEREN_00002685

APPENDIX A

Non CCR Rule Program Potentiometric Surface Maps

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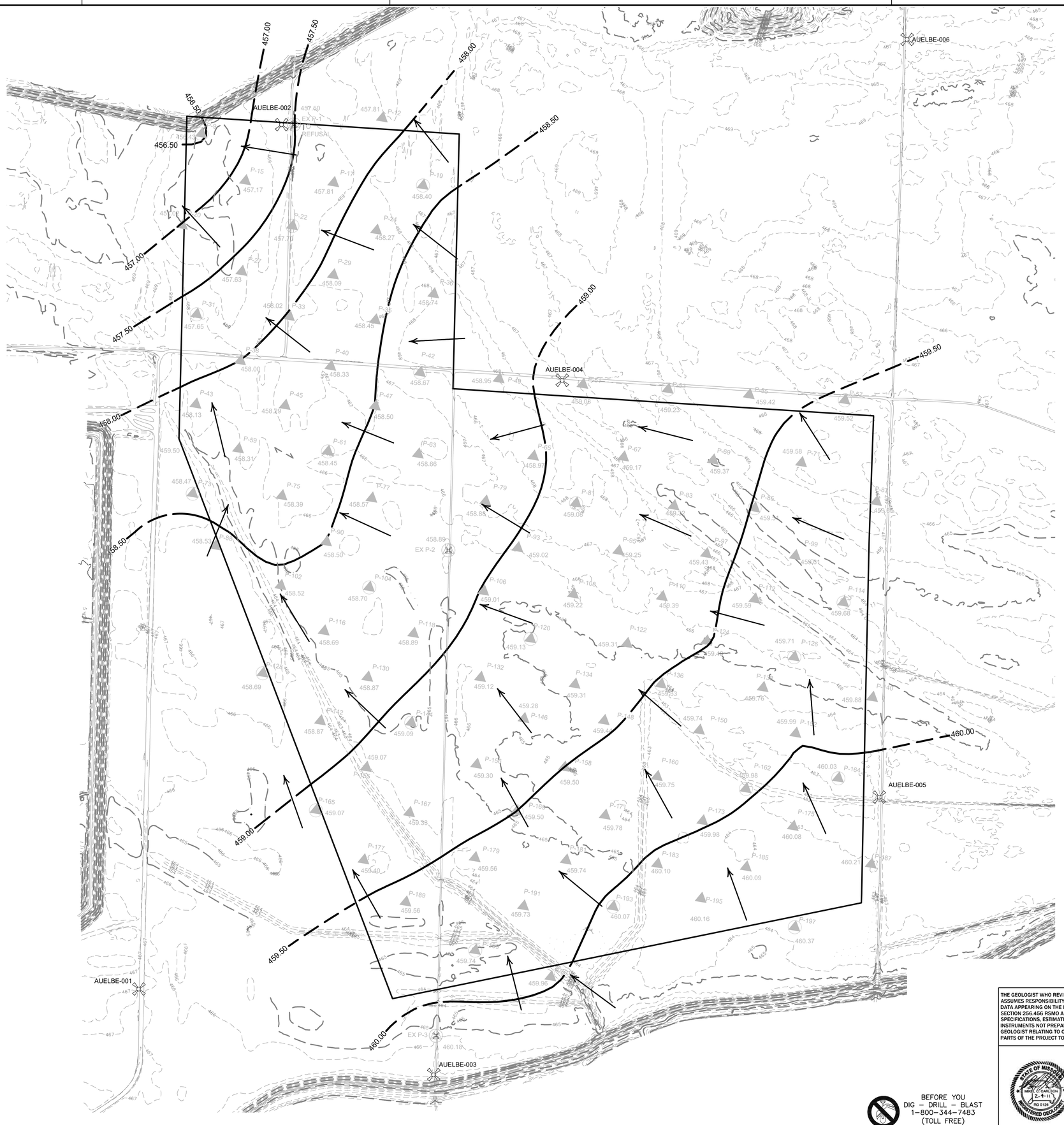
REV.	W.O.	



N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
December 21, 2009
451.3 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00006161 FT./FT. TO 0.001912 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 451.3 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 14.5 FT. DECREASE IN RIVER ELEVATION BEGINNING ON NOVEMBER 20, 2009.

S□R□E□ MON□MENTS

MON□MENT ID	NORT□ING	EASTING	ELE□ATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

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1055 CORPORATE SQUARE DRIVE
ST. LOUIS, MISSOURI 63132
314.993.4132 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1585 East High Street Telephone: (573) 659-9078
Jefferson City, Missouri 65101 Facsimile: (573) 659-9079

PREPARED FOR Ameren MISSOURI

MARK C. CARLSON
2-9-11
RG 0126
REGISTERED GEOLOGIST
STATE OF MISSOURI

DRAWN 020411 W.J.A. (GER)	FIGURE 18		
CHKD. M.C.C. (GER)	DETAILED SITE INVESTIGATION		
SUPV. M.C.C. (GER)	PROPOSED UTILITY WASTE DISPOSAL AREA		
APPD. M.C.C. (GER)	WATER TABLE SURFACE MAP - DECEMBER 21, 2009		
	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren MISSOURI	ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG	REV.

M:\Drawn Q&D\Proj\AMEREN\LBE\LABADIE\100 Groundwater\FIGS (18) THRU (29)(33).DWG, 2/4/2011 3:29:55 PM, GWG To PDF.ctb

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REVISIONS	
REV.	W.O.

MISSOURI RIVER ELEVATION:
December 21, 2009
451.3 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00006161 FT./FT. TO 0.001912 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 451.3 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 14.5 FT. DECREASE IN RIVER ELEVATION BEGINNING ON NOVEMBER 20, 2009.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

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GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1991 East 16th Street Telephone: (573) 438-7672
Jefferson City, Missouri 65101 Facsimile: (573) 635-7879

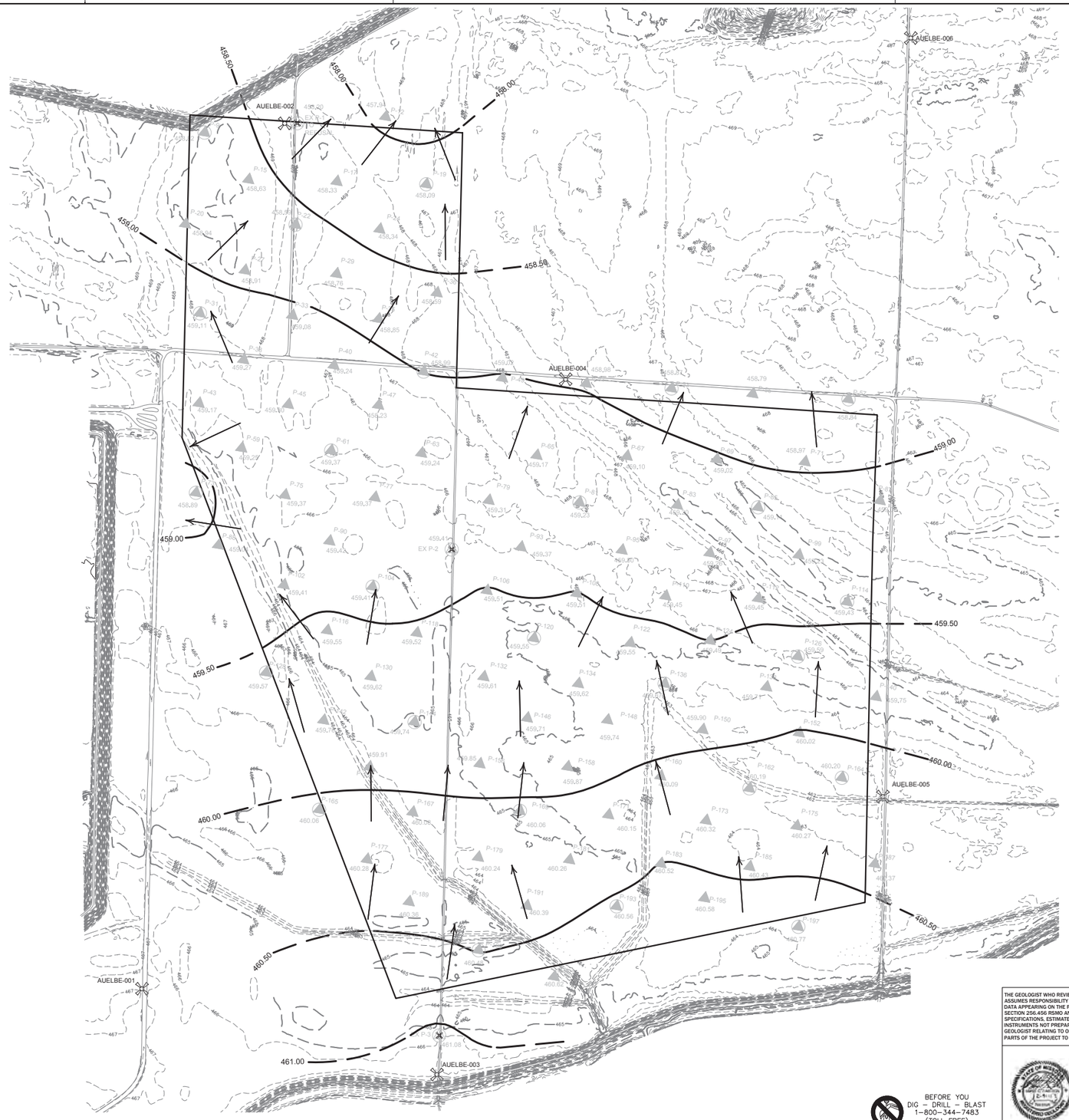
PREPARED FOR Ameren

DRAWN 020411 W.J.A. (GER)	FIGURE 18 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - DECEMBER 21, 2009		
CHKD. M.C.C. (GER)			
SUPV. M.C.C. (GER)			
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren MISSOURI ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG		REV.

PRINT DIST.

REVISIONS

REV.	W.O.	



N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
January 25, 2010
465.9 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00004573 FT./FT. TO 0.00106 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 465.9 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 13.5 FT. RISE IN RIVER ELEVATION BEGINNING ON JANUARY 18, 2010.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

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GREDELL Engineering Resources, Inc.
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DRAWN 020411 W.J.A. (GER)	FIGURE 19 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - JANUARY 25, 2010	
CHKD. M.C.C. (GER)		
SUPV. M.C.C. (GER)		
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT — CLASS 02010
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG	REV.

H:\Revit CAD\Rev Labadie\Rev Labadie CCR Groundwater\FIGS (18 THRU (29) (33).DWG, 8.5"X11.0 LAST PM, DWG by RUFUS

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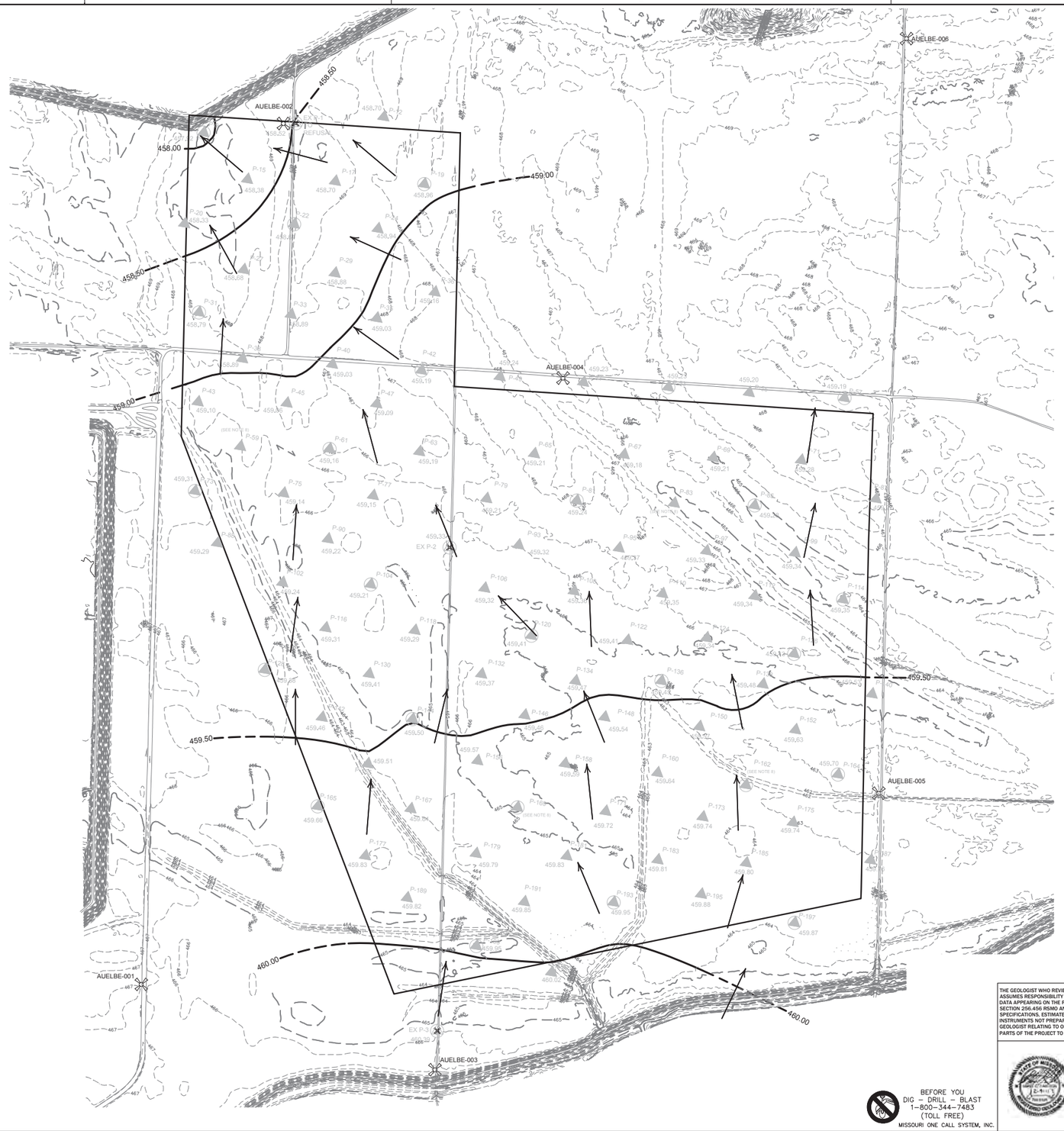
REV.	W.O.	



N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
February 16, 2010
454.0 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.000003049 FT./FT. TO 0.005547 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 454.0 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 4.2 FT. DECREASE IN RIVER ELEVATION BEGINNING ON FEBRUARY 11, 2010.
8. GROUNDWATER ELEVATION READINGS FOR P-59, P-83, P-162, AND P-169 ARE SUSPECTED MEASUREMENT ERRORS. VALUES NOT CONSIDERED REPRESENTATIVE OF TRUE GROUNDWATER CONDITIONS (SEE TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
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DRAWN 020411 W.J.A. (GER)	FIGURE 20
CHKD. M.C.C. (GER)	DETAILED SITE INVESTIGATION
SUPV. M.C.C. (GER)	PROPOSED UTILITY WASTE DISPOSAL AREA
APPD. M.C.C. (GER)	WATER TABLE SURFACE MAP - FEBRUARY 16, 2010
LOCATION 001004	LABADIE PLANT
CLASS 02010	
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG
REV.	

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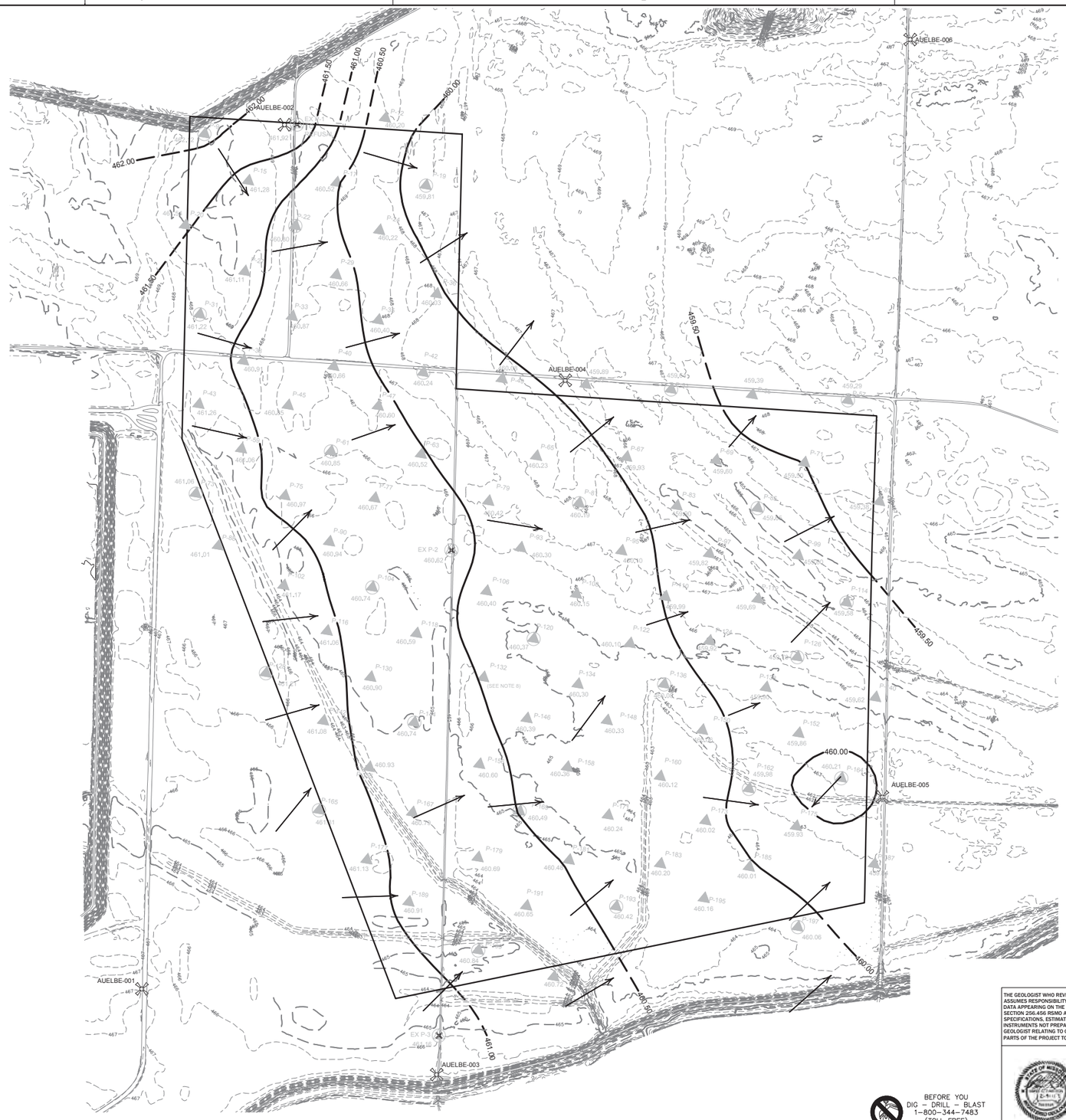

N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
March 16, 2010
468.2 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.000006952 FT./FT. TO 0.003517 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 468.2 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 13.5 FT. RISE IN RIVER ELEVATION BEGINNING ON MARCH 8, 2010.
8. GROUNDWATER ELEVATION READING FOR P-132 IS SUSPECTED MEASUREMENT ERROR. VALUE NOT CONSIDERED REPRESENTATIVE OF TRUE GROUNDWATER CONDITIONS (SEE TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

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1056 CORPORATE SQUARE DRIVE
ST. LOUIS, MISSOURI 63132
314.993.4132 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1585 East Hwy. Tenant Telephone (573) 438-5678
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DRAWN 020411 W.J.A. (GER)	FIGURE 21 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - MARCH 16, 2010	
CHKD. M.C.C. (GER)		
SUPV. M.C.C. (GER)		
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT — CLASS 02010
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG	REV.

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REVISIONS

REV.	W.O.	

N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
April 13, 2010
462.4 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.000009415 FT./FT. TO 0.0006961 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 462.4 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 4.3 FT. DECREASE IN RIVER ELEVATION BEGINNING ON APRIL 13, 2010.
8. GROUNDWATER ELEVATION READING FOR P-35 IS SUSPECTED MEASUREMENT ERROR. VALUE NOT CONSIDERED REPRESENTATIVE OF TRUE GROUNDWATER CONDITIONS (SEE TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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CHKD. M.C.C. (GER)
SUPV. M.C.C. (GER)
APPD. M.C.C. (GER)

FIGURE 22
DETAILED SITE INVESTIGATION
PROPOSED UTILITY WASTE DISPOSAL AREA
WATER TABLE SURFACE MAP - APRIL 13, 2010

LOCATION 001004 | LABADIE PLANT | CLASS 02010

Ameren MISSOURI ST. LOUIS, MISSOURI | FIGS (18) THRU (29)(33).DWG | REV.

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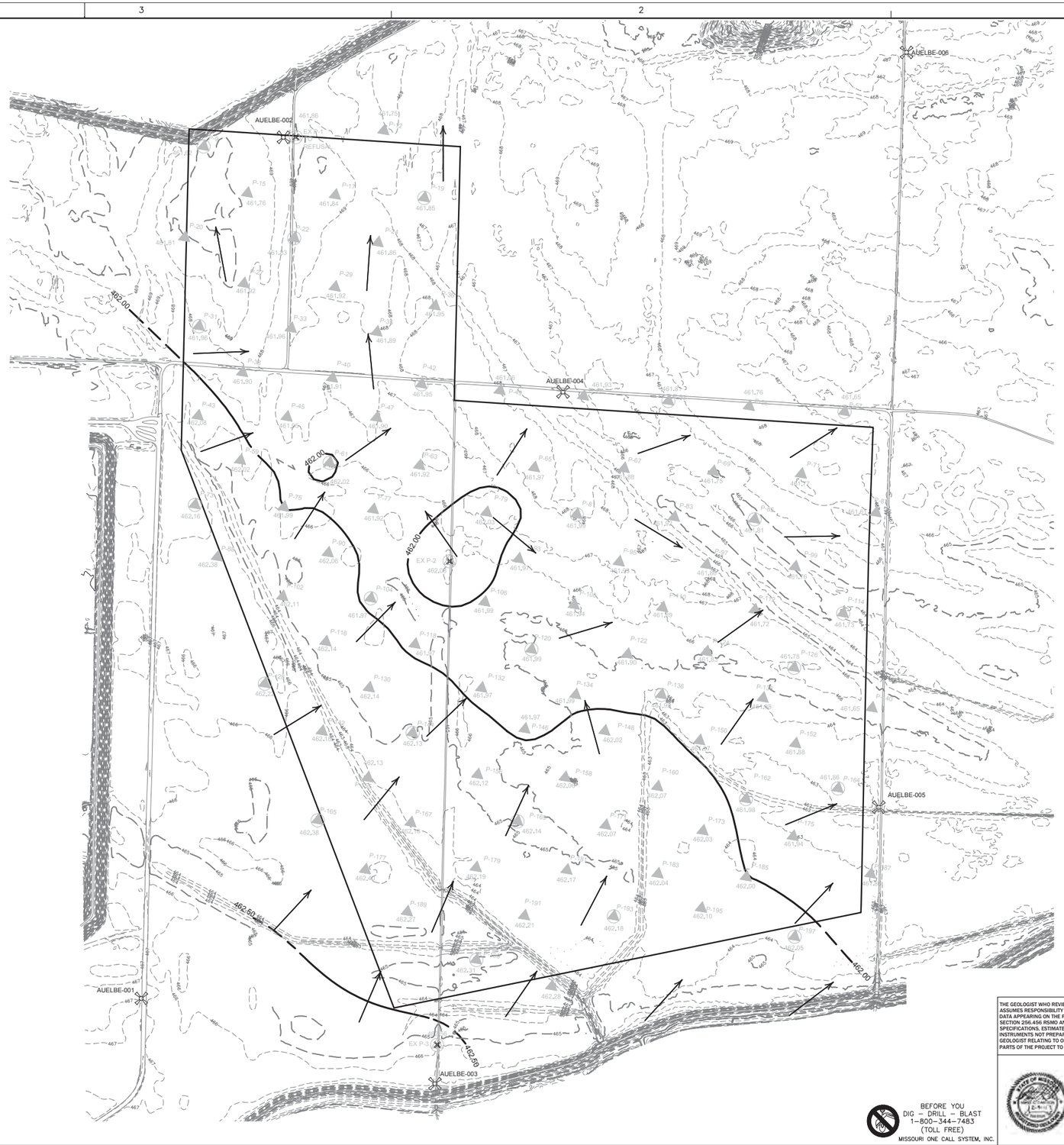

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SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
May 11, 2010
460.7 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00000529 FT./FT. TO 0.0007999 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 460.7 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 8.7 FT. DECREASE IN RIVER ELEVATION BEGINNING ON APRIL 28, 2010.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
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ST. LOUIS, MISSOURI 63132
314.993.4132 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
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DRAWN 020411 W.J.A. (GER)	FIGURE 23 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - MAY 11, 2010		
CHKD. M.C.C. (GER)			
SUPV. M.C.C. (GER)			
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG		REV.

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M:\Gen\CADD\Ameren\LABADIE\Drawings\FIGS\GW_CONTOURS\FIG (29)(33).DWG, 8.5 X 11(1:1), Model, Tim McFall

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SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
June 8, 2010
465.9 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.) (★SEE NOTE 9)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00003298 FT./FT. TO 0.0009193 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 465.9 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 1.0 FT. DECREASE IN RIVER ELEVATION BEGINNING ON JUNE 6, 2010.
8. NO MEASUREMENT. PIEZOMETER COULD NOT BE ACCESSED.
9. GROUNDWATER ELEVATIONS ABOVE APPARENT GROUND SURFACE ELEVATIONS IN P-102, P-150, P-155, P-165, P-167, AND P-177 (SEE ALSO TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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ST. LOUIS, MISSOURI 63132
314.993.4132 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
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DRAWN 020411 W.J.A. (GER)	FIGURE 24 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - JUNE 8, 2010		
CHKD. M.C.C. (GER)			
SUPV. M.C.C. (GER)			
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG		REV.

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M:\Gen\CADD\Ameren\AMERIGAS Groundwater\FIGS\GW TYPE (29)(33).DWG, 3/4/2013 8:08:08 AM, DeskJet PS.PLP

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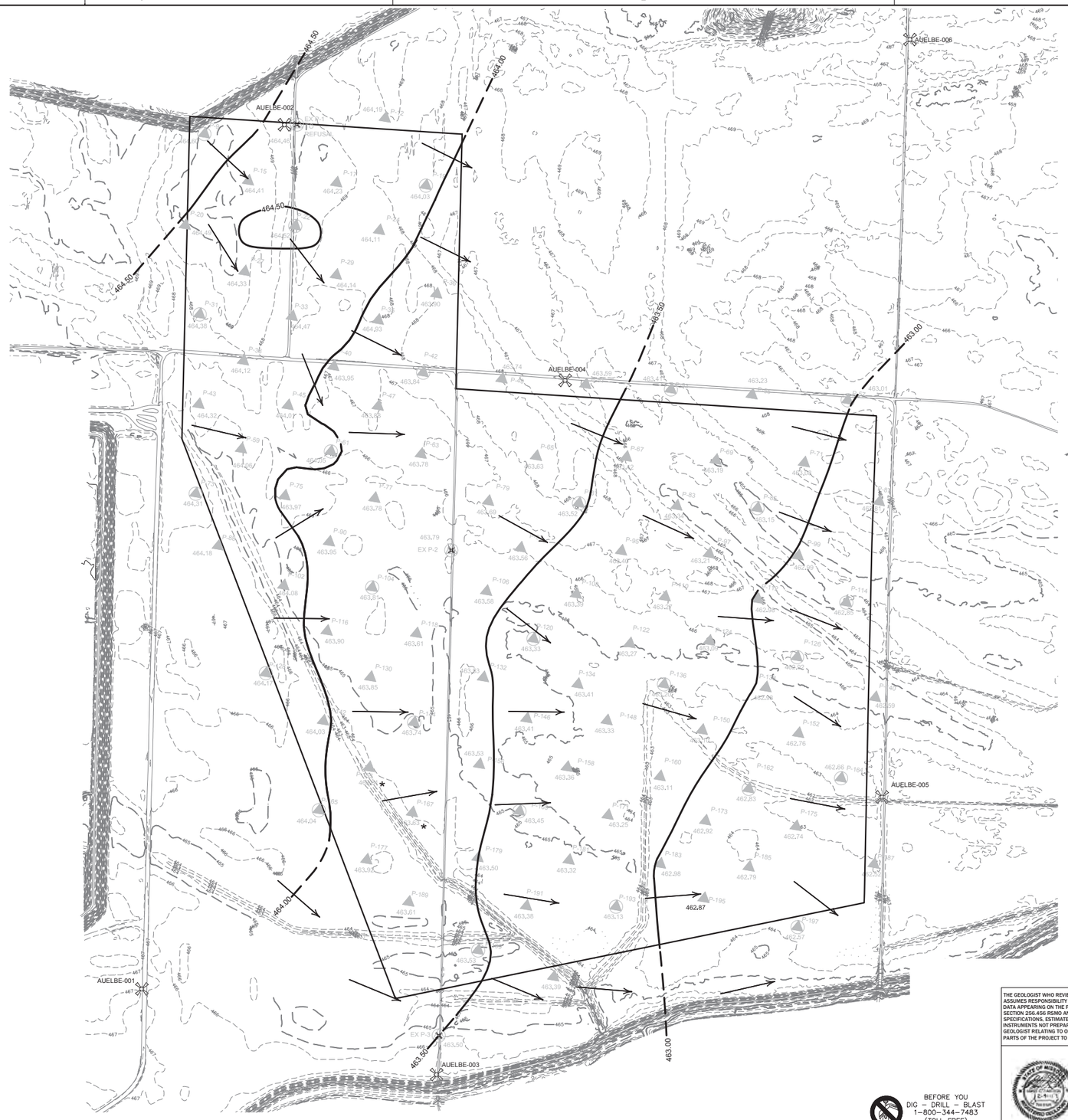

N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
July 7, 2010
465.0 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.) (★SEE NOTE 8)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00001928 FT./FT. TO 0.001323 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 465.0 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 3.9 FT. DECREASE IN RIVER ELEVATION BEGINNING ON JUNE 30, 2010.
8. GROUNDWATER ELEVATIONS ABOVE APPARENT GROUND SURFACE ELEVATIONS IN P-155 AND P-167 (SEE ALSO TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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FIGURE 25
DETAILED SITE INVESTIGATION
PROPOSED UTILITY WASTE DISPOSAL AREA
WATER TABLE SURFACE MAP - JULY 7, 2010

LOCATION 001004 | LABADIE PLANT | CLASS 02010

Ameren ST. LOUIS, MISSOURI | FIGS (18) THRU (29)(33).DWG | REV.

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SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
August 5, 2010
462.9 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND REITZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.000006144 FT./FT. TO 0.001152 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 462.9 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 2.5 FT. DECREASE IN RIVER ELEVATION BEGINNING ON AUGUST 1, 2010.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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Vertical Datum NAVD 1988

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DRAWN 020411 W.J.A. (GER)	FIGURE 26 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - AUGUST 5, 2010	
CHKD. M.C.C. (GER)		
SUPV. M.C.C. (GER)		
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT
CLASS 02010		
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG	REV.

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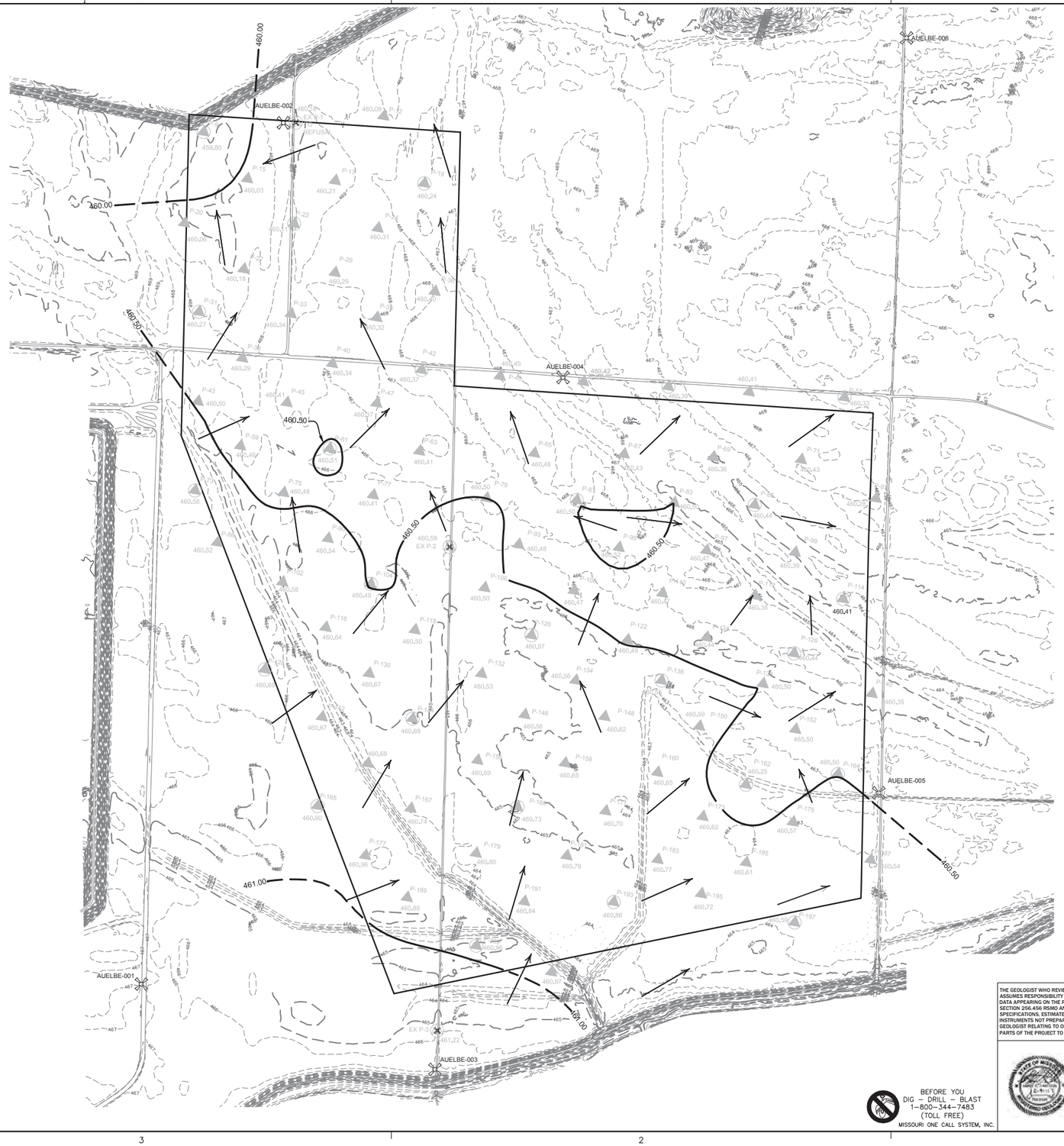

N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
September 8, 2010
458.5 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES:

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES AND RIETZ AND JENS FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00000395 FT./FT. TO 0.001044 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 458.5 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 3.1 FT. DECREASE IN RIVER ELEVATION BEGINNING ON SEPTEMBER 4, 2010.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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DRAWN 020411 W.J.A. (GER)	FIGURE 27 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - SEPTEMBER 8, 2010		
CHKD. M.C.C. (GER)			
SUPV. M.C.C. (GER)			
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren MISSOURI	ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG	REV.

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SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
October 7, 2010
460.3 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES:

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.000002977 FT./FT. TO 0005534 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 460.3 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 8.5 FT. DECREASE IN RIVER ELEVATION BEGINNING ON SEPTEMBER 25, 2010.
8. GROUNDWATER ELEVATION READING FOR P-61 IS SUSPECTED MEASUREMENT ERROR. VALUE NOT CONSIDERED REPRESENTATIVE OF TRUE GROUNDWATER CONDITIONS (SEE TABLE 3).

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

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1055 CORPORATE SQUARE DRIVE
ST. LOUIS, MISSOURI 63132
314.993.4132 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1505 East High Street Jefferson City, Missouri 65101
Telephone: (573) 659-9078 Facsimile: (573) 659-9079

PREPARED FOR Ameren

DRAWN 020411 W.J.A. (GER)
CHKD. M.C.C. (GER)
SUPV. M.C.C. (GER)
APPD. M.C.C. (GER)

FIGURE 28
DETAILED SITE INVESTIGATION
PROPOSED UTILITY WASTE DISPOSAL AREA
WATER TABLE SURFACE MAP - OCTOBER 7, 2010

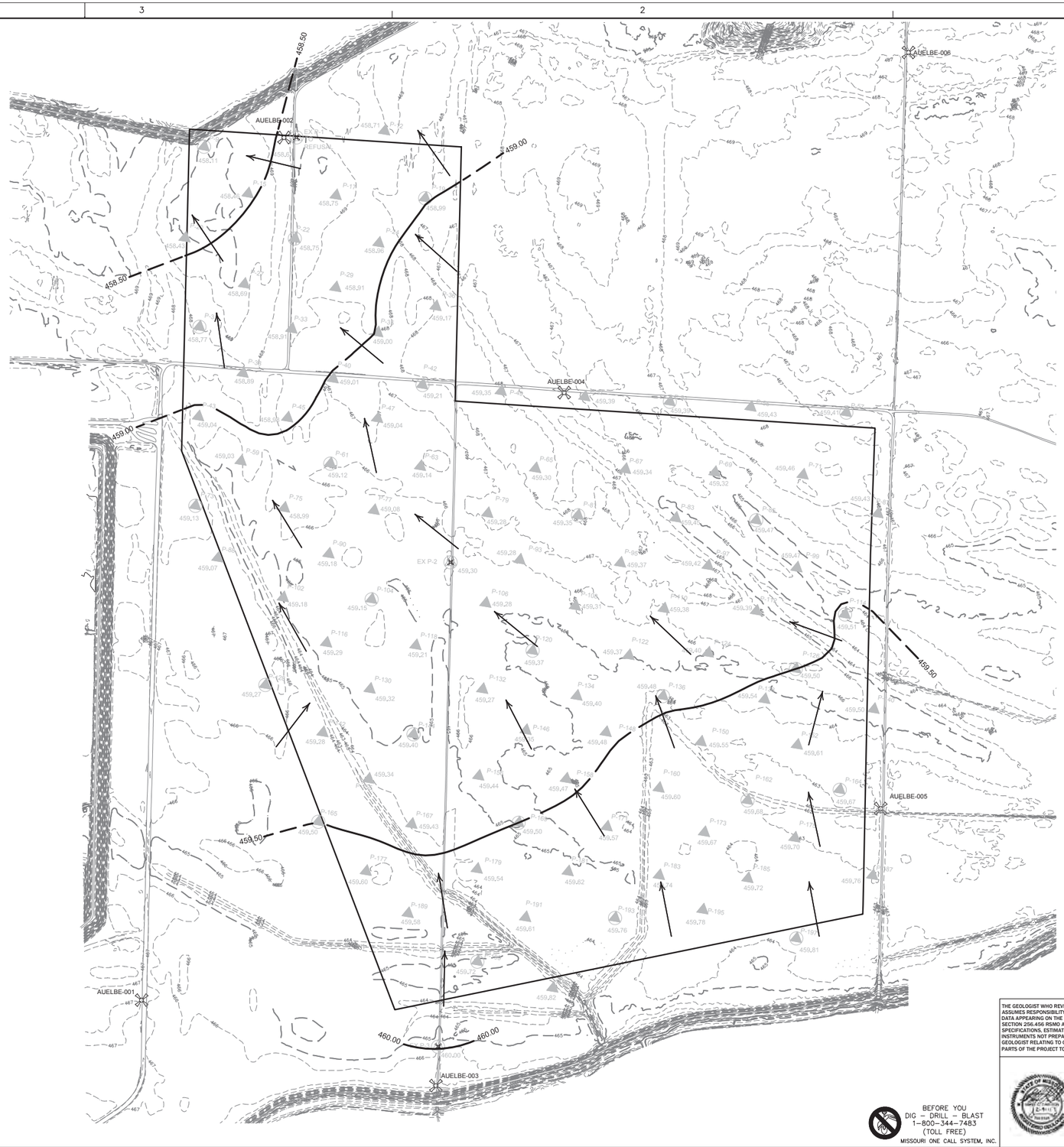
LOCATION 001004 | LABADIE PLANT | CLASS 02010

Ameren MISSOURI ST. LOUIS, MISSOURI | FIGS (18) THRU (29)(33).DWG | REV.

PRINT DIST.

REVISIONS

REV.	W.O.	



N

SCALE: 1" = 300'

0 150 300 600

MISSOURI RIVER ELEVATION:
November 4, 2010
456.8 ft Ameren Missouri - Labadie Power Plant Gauging Station

LEGEND

- 2007 PIEZOMETER
- 2" PIEZOMETER
- 4" PIEZOMETER
- SURVEY MONUMENT
- 459.23 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 460.00 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

NOTES:

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. GROUNDWATER DATA NOT AVAILABLE FOR TEMPORARY AND CPT BORINGS.
3. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES FIELD PERSONNEL.
4. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
5. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
6. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 0.00000199 FT./FT. TO 0.0008934 FT./FT.
7. MISSOURI RIVER GAUGE ELEVATION = 456.8 FT. ON DATE OF WATER LEVEL MONITORING AS MEASURED AT LABADIE POWER PLANT. THIS REPRESENTS AN APPROXIMATE 3.5 FT. DECREASE IN RIVER ELEVATION BEGINNING ON OCTOBER 7, 2010.

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996728.98	731621.69	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

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GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1909 East High Street Telephone (573) 635-9676
Jefferson City, Missouri 65101 Facsimile (573) 635-9679

PREPARED FOR Ameren

DRAWN 020411 W.J.A. (GER)	FIGURE 29 DETAILED SITE INVESTIGATION PROPOSED UTILITY WASTE DISPOSAL AREA WATER TABLE SURFACE MAP - NOVEMBER 4, 2010		
CHKD. M.C.C. (GER)			
SUPV. M.C.C. (GER)			
APPD. M.C.C. (GER)	LOCATION 001004	LABADIE PLANT	CLASS 02010
Ameren ST. LOUIS, MISSOURI	FIGS (18) THRU (29)(33).DWG		REV.

H:\Gpro\C3D\Proj_LABADIE\Dsd_LABADIE\DSD Groundwater\FIGS (18) THRU (29)(33).DWG, 3/4 (29.3 x 22.4), Model, Tu, Plot Jul 6

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REVISIONS		
REV.	W.O.	SYM

LEGEND

- 2" MONITORING WELL
- SURVEY MONUMENT
- 453.45 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION REFERENCE VECTOR. SIZE OF ARROW PROPORTIONAL TO MAGNITUDE OF GROUNDWATER FLOW GRADIENT.
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 454 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996729.00	731621.70	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES, INC. FIELD PERSONNEL ON APRIL 16 AND 17, 2013
3. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENT.
4. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
5. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 9.65×10^{-6} FT./FT. TO 7.56×10^{-3} FT./FT.

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ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1000 East 45th Street, Hillcrest Bldg., Missouri 65201
Telephone: (573) 499-0670
Facsimile: (573) 499-0674

PREPARED FOR AMEREN MISSOURI

DRAWN W.J.A./A.J.K. (G.E.R.)	FIGURE 1	
CHKD. M.C.C. (G.E.R.)	1st BACKGROUND SAMPLING EVENT - APRIL 2013	
SUPV. M.C.C. (G.E.R.)	WATER TABLE SURFACE CONTOUR MAP	
APPD. T.A.D. (G.E.R.)	PROPOSED UTILITY WASTE LANDFILL	
LOCATION 001009	LABADIE ENERGY CENTER	CLASS 02010
AMEREN MISSOURI ST. LOUIS, MISSOURI	MAY 2013	REV. 0

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REVISIONS		
REV.	W.O.	SYM

N

SCALE: 1" = 300'

0 150 300 600

LEGEND

- 2" MONITORING WELL
- SURVEY MONUMENT
- 453.45 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION REFERENCE VECTOR, SIZE OF ARROW PROPORTIONAL TO MAGNITUDE OF GROUNDWATER FLOW GRADIENT.
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 454 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996729.00	731621.70	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES, INC. FIELD PERSONNEL ON AUGUST 19, 20, AND 21, 2013
3. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENTS.
4. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
5. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 1.57×10^{-6} FT./FT. TO 3.00×10^{-3} FT./FT.
6. GROUNDWATER ELEVATION READING FOR MW-27 IS SUSPECTED MEASUREMENT ERROR, VALUE NOT CONSIDERED REPRESENTATIVE OF TRUE GROUNDWATER CONDITIONS (SEE TABLE 2).

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3105 CORPORATE SQUARE DRIVE
ST. LOUIS, MISSOURI 63132
314.993.4132 (VOICE) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND ABR WATER
1005 East High Street Telephone (573) 499-9078
Jefferson City, Missouri 65101 Facsimile (573) 499-9079

PREPARED FOR AMEREN MISSOURI

DRAWN M.J.W. (G.E.R.)	FIGURE 1
CHKD. M.C.C. (G.E.R.)	2nd BACKGROUND SAMPLING EVENT - AUGUST 2013
SUPV. M.C.C. (G.E.R.)	WATER TABLE SURFACE CONTOUR MAP
APPD. T.A.D. (G.E.R.)	PROPOSED UTILITY WASTE LANDFILL
LOCATION 001009	LABADIE ENERGY CENTER — CLASS 02010
AMEREN MISSOURI ST. LOUIS, MISSOURI	SEPTEMBER 2013 — REV. 0

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AMEREN_00002701

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REVISIONS		
REV.	W.O.	SYM

SCALE: 1" = 300'
0 150 300 600

LEGEND

- 2" MONITORING WELL
- SURVEY MONUMENT
- 453.45 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION REFERENCE VECTOR. SIZE OF ARROW PROPORTIONAL TO MAGNITUDE OF GROUNDWATER FLOW GRADIENT.
- EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 453 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

SURVEY MONUMENTS

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES, INC. FIELD PERSONNEL ON NOVEMBER 19 AND 20, 2013.
3. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENTS.
4. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
5. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 3.11×10^{-5} FT./FT. TO 6.38×10^{-4} FT./FT.

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GREDELL Engineering Resources, Inc. ENVIRONMENTAL ENGINEERING

PREPARED FOR AMEREN

DRAWN	A.J.K. (G.E.R.)
CHKD.	T.A.D. (G.E.R.)
SUPV.	T.R.O. (G.E.R.)
APVD.	M.C.C. (G.E.R.)

FIGURE 1
3rd BACKGROUND SAMPLING EVENT - NOVEMBER 2013
WATER TABLE SURFACE CONTOUR MAP
PROPOSED UTILITY WASTE LANDFILL

LOCATION		CLASS
001009	LABADIE ENERGY CENTER	02010
AMEREN ST. LOUIS, MISSOURI	DECEMBER 2013	REV. 0

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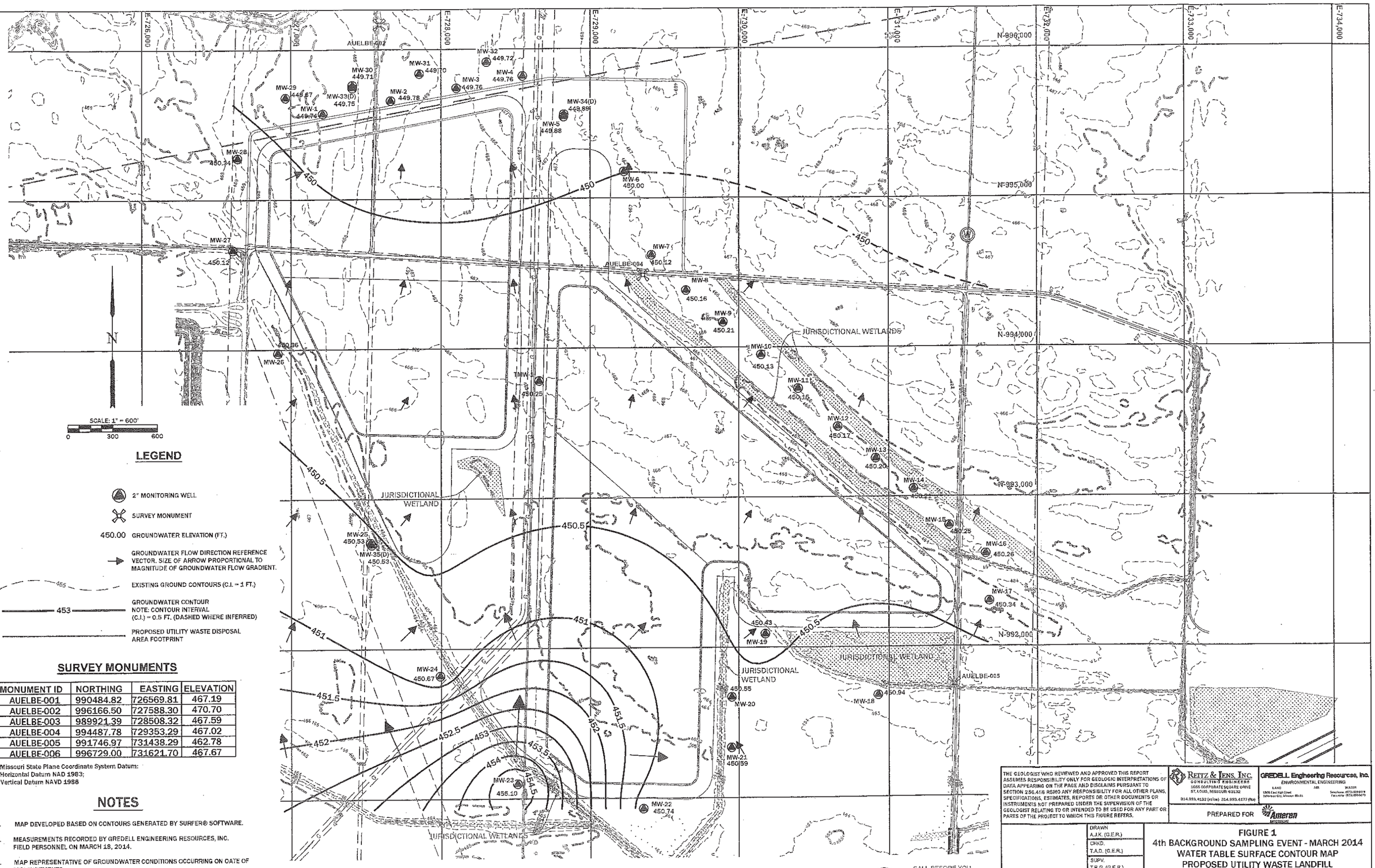
REVISIONS		
REV.	W.O.	SYM



LEGEND

- 2" MONITORING WELL
- SURVEY MONUMENT
- 450.00 GROUNDWATER ELEVATION (FT.)
- GROUNDWATER FLOW DIRECTION REFERENCE VECTOR. SIZE OF ARROW PROPORTIONAL TO MAGNITUDE OF GROUNDWATER FLOW GRADIENT.
- 465 EXISTING GROUND CONTOURS (C.I. = 1 FT.)
- 453 GROUNDWATER CONTOUR NOTE: CONTOUR INTERVAL (C.I.) = 0.5 FT. (DASHED WHERE INFERRED)
- PROPOSED UTILITY WASTE DISPOSAL AREA FOOTPRINT

SURVEY MONUMENTS

MONUMENT ID	NORTHING	EASTING	ELEVATION
AUELBE-001	990484.82	726569.81	467.19
AUELBE-002	996166.50	727588.30	470.70
AUELBE-003	989921.39	728508.32	467.59
AUELBE-004	994487.78	729353.29	467.02
AUELBE-005	991746.97	731438.29	462.78
AUELBE-006	996729.00	731621.70	467.67

Missouri State Plane Coordinate System Datum:
Horizontal Datum NAD 1983;
Vertical Datum NAVD 1988

NOTES

1. MAP DEVELOPED BASED ON CONTOURS GENERATED BY SURFER® SOFTWARE.
2. MEASUREMENTS RECORDED BY GREDELL ENGINEERING RESOURCES, INC. FIELD PERSONNEL ON MARCH 18, 2014.
3. MAP REPRESENTATIVE OF GROUNDWATER CONDITIONS OCCURRING ON DATE OF MEASUREMENTS.
4. USE OF SMALL CONTOUR INTERVAL (0.5 FT.) EXAGGERATES APPARENT "SLOPE" OF WATER TABLE SURFACE.
5. RANGE OF GROUNDWATER FLOW GRADIENT AS DETERMINED BY SURFER® SOFTWARE 1.52×10^{-3} FT./FT. TO 5.84×10^{-3} FT./FT.

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314.993.4122 (voice) 314.993.4177 (fax)

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING
LAND AIR WATER
1806 East High Street, Jefferson City, Missouri 65101
Telephone: (573) 893-9378
Fax/voice: (573) 893-9479

PREPARED FOR Ameren MISSOURI

DRAWN	A.J.K. (G.E.R.)
CHKD.	T.A.D. (G.E.R.)
SUPV.	T.R.G. (G.E.R.)
APPD.	M.C.C. (G.E.R.)

FIGURE 1
4th BACKGROUND SAMPLING EVENT - MARCH 2014
WATER TABLE SURFACE CONTOUR MAP
PROPOSED UTILITY WASTE LANDFILL

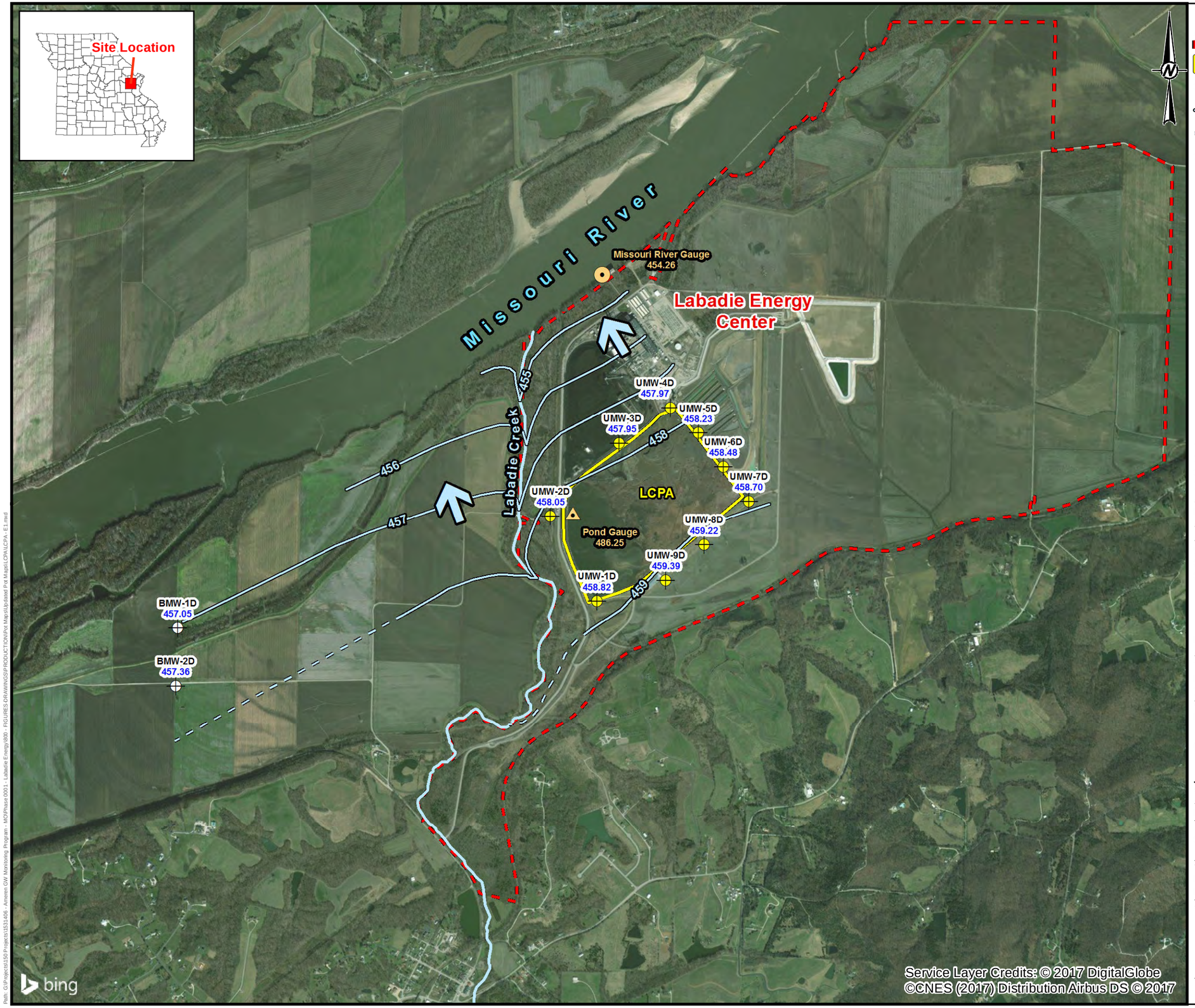
LOCATION		CLASS
001009	LABADIE ENERGY CENTER	02010

Ameren MISSOURI — ST. LOUIS, MISSOURI — APRIL 2014 — REV. 0

AMEREN_00002703

APPENDIX B

CCR Rule Program Potentiometric Surface Maps



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 5001,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 1 - MARCH 22, 2016

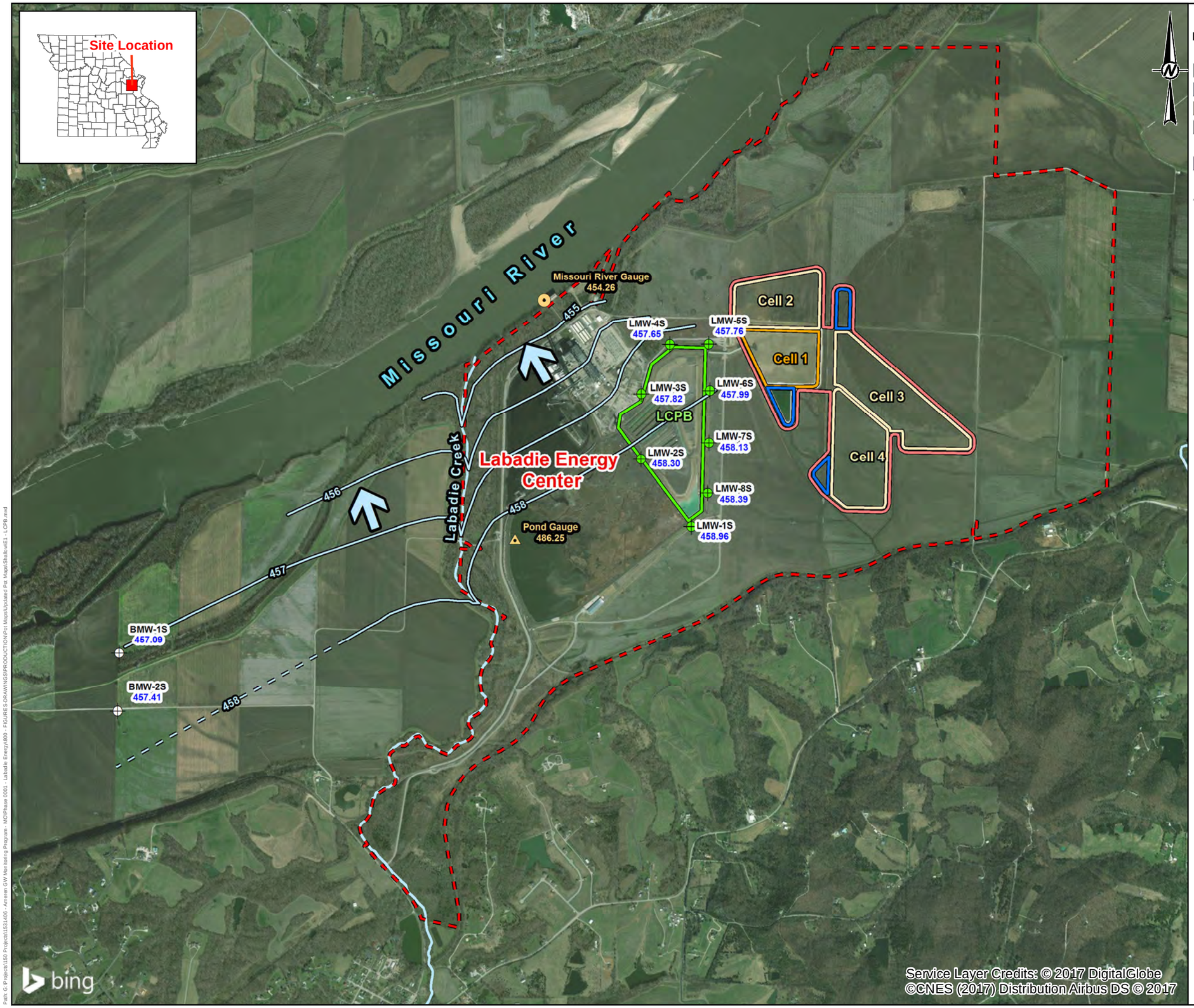
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-03-31
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - E1.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Current Cell Under Construction
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
7. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 1 - MARCH 22, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-31
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001B	0.0	**B2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

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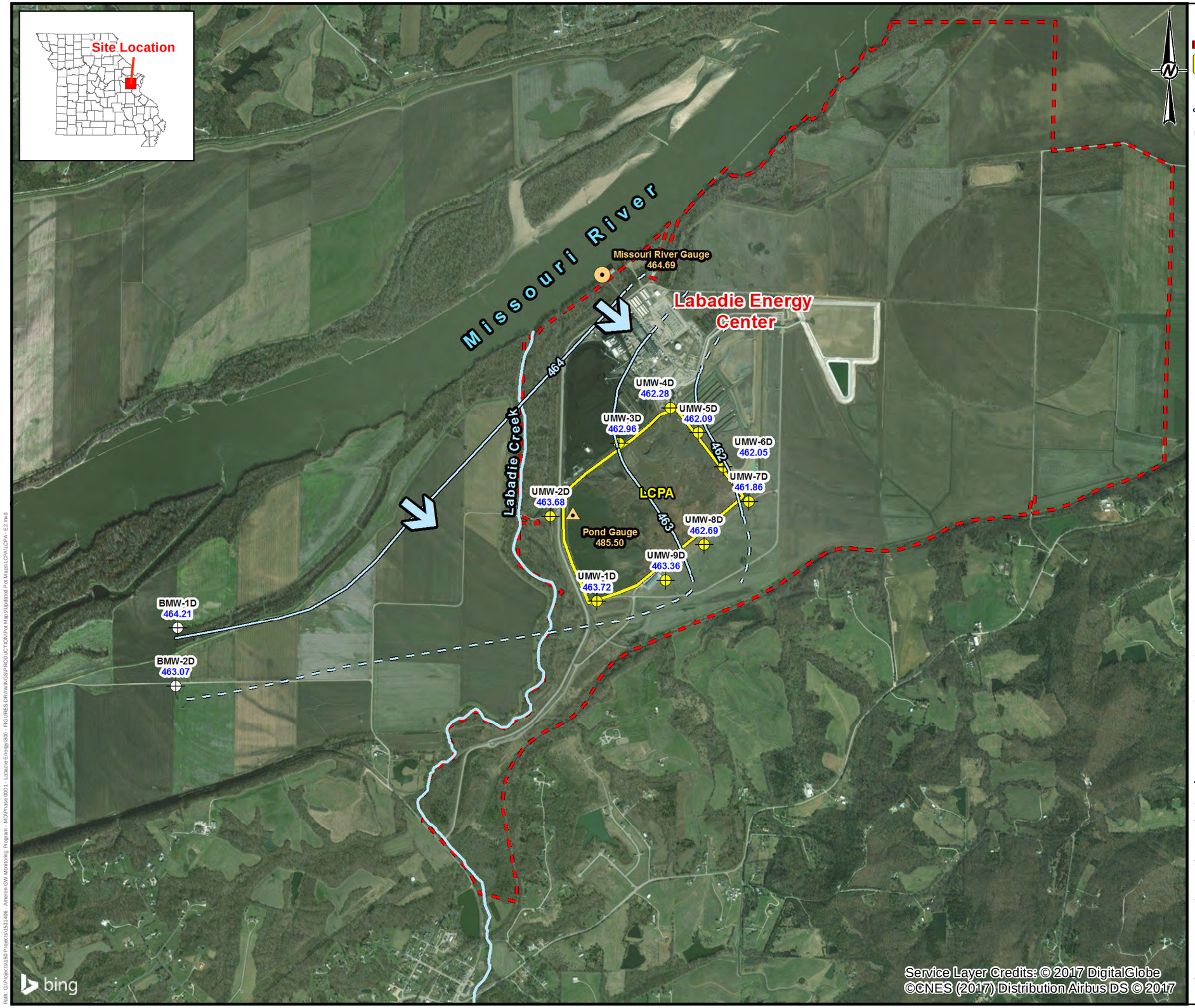


LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 2 - MAY 3, 2016

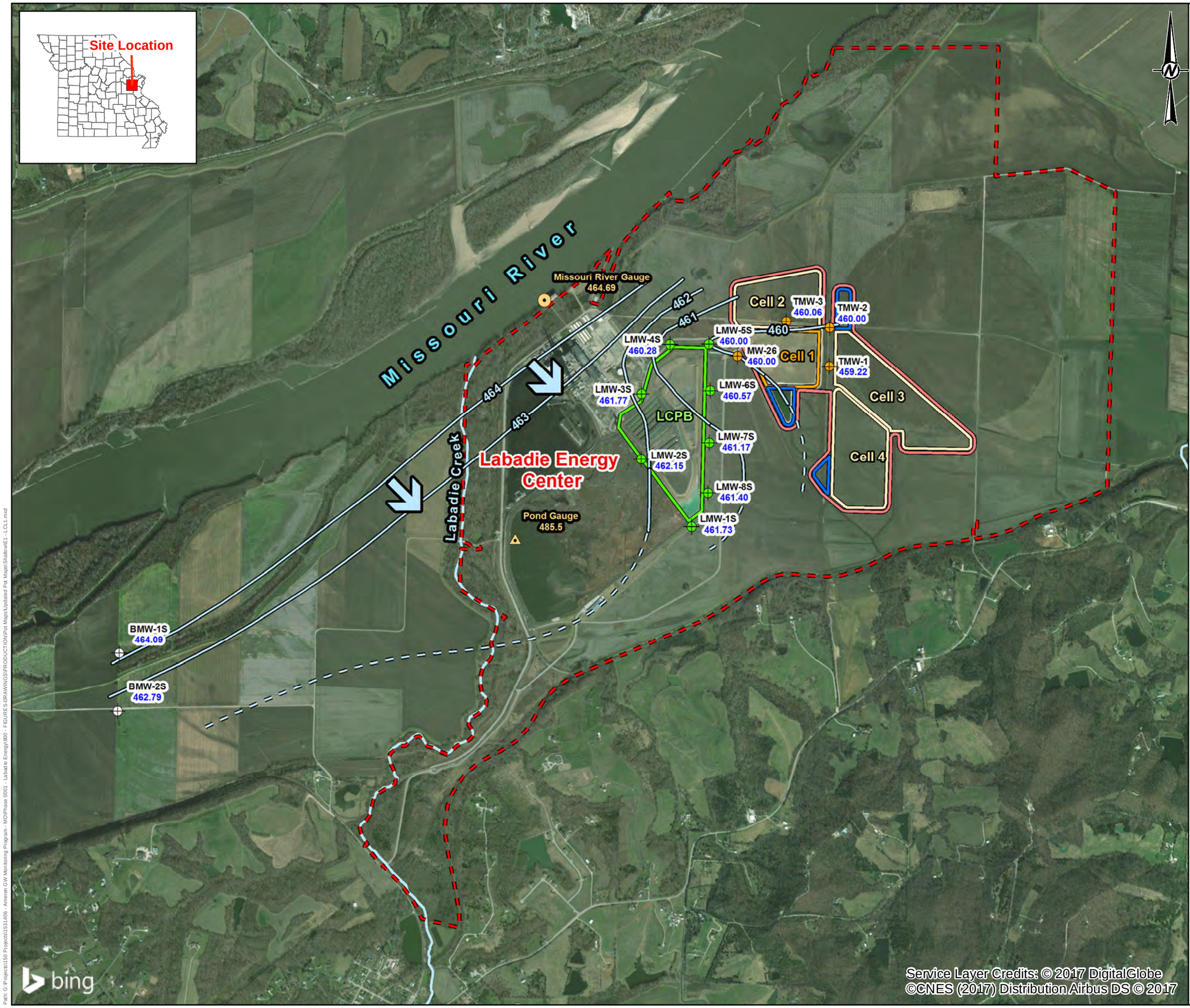
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-25
PREPARED	JS
DESIGN	JSI
REVIEW	JSI
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - E2.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ & JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 2 - MAY 3, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-31
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B4**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

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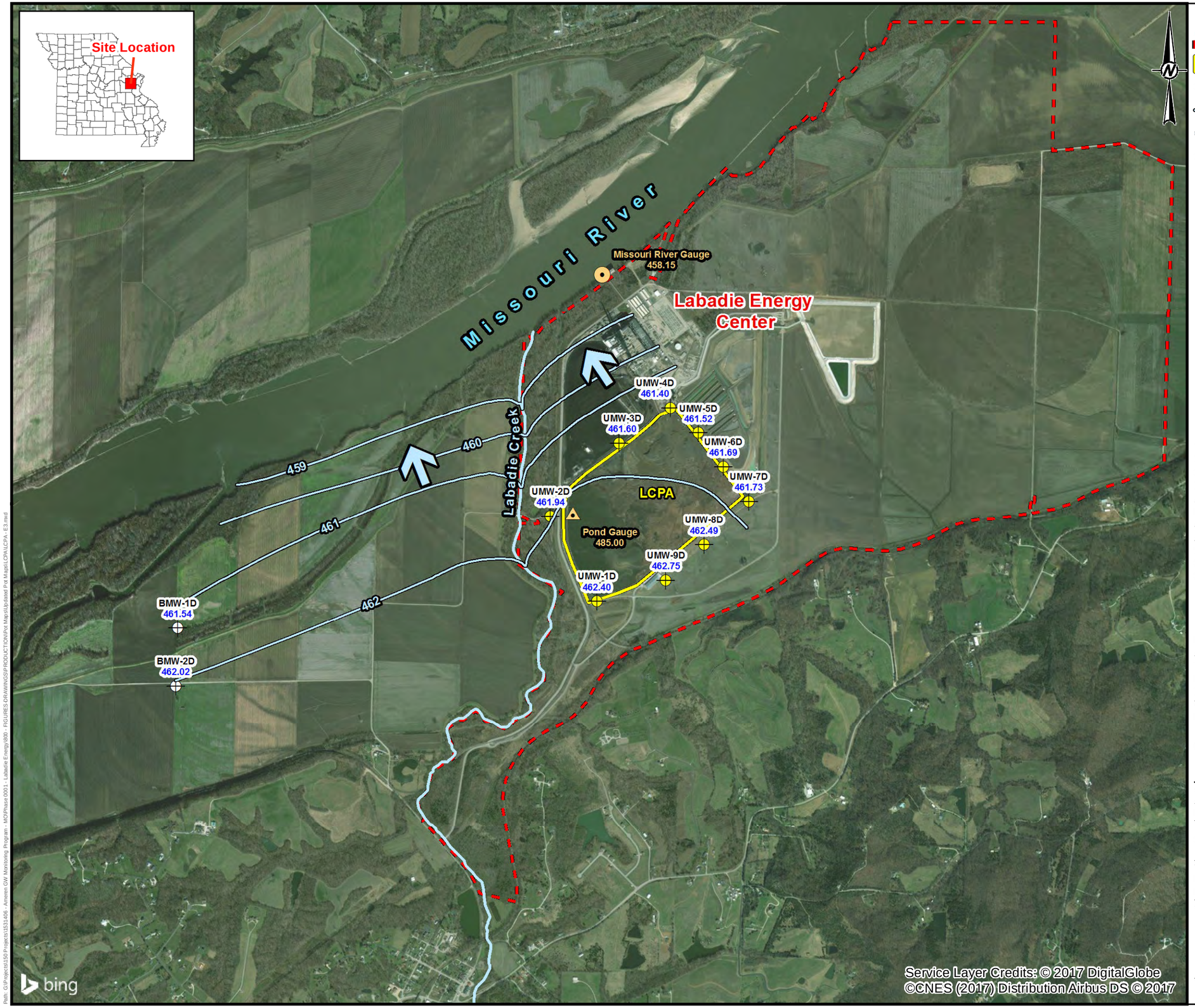

LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 5001,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 3 - JULY 11, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-21
PREPARED	JS
DESIGN	JSI
REVIEW	RJF/JSI
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B5**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

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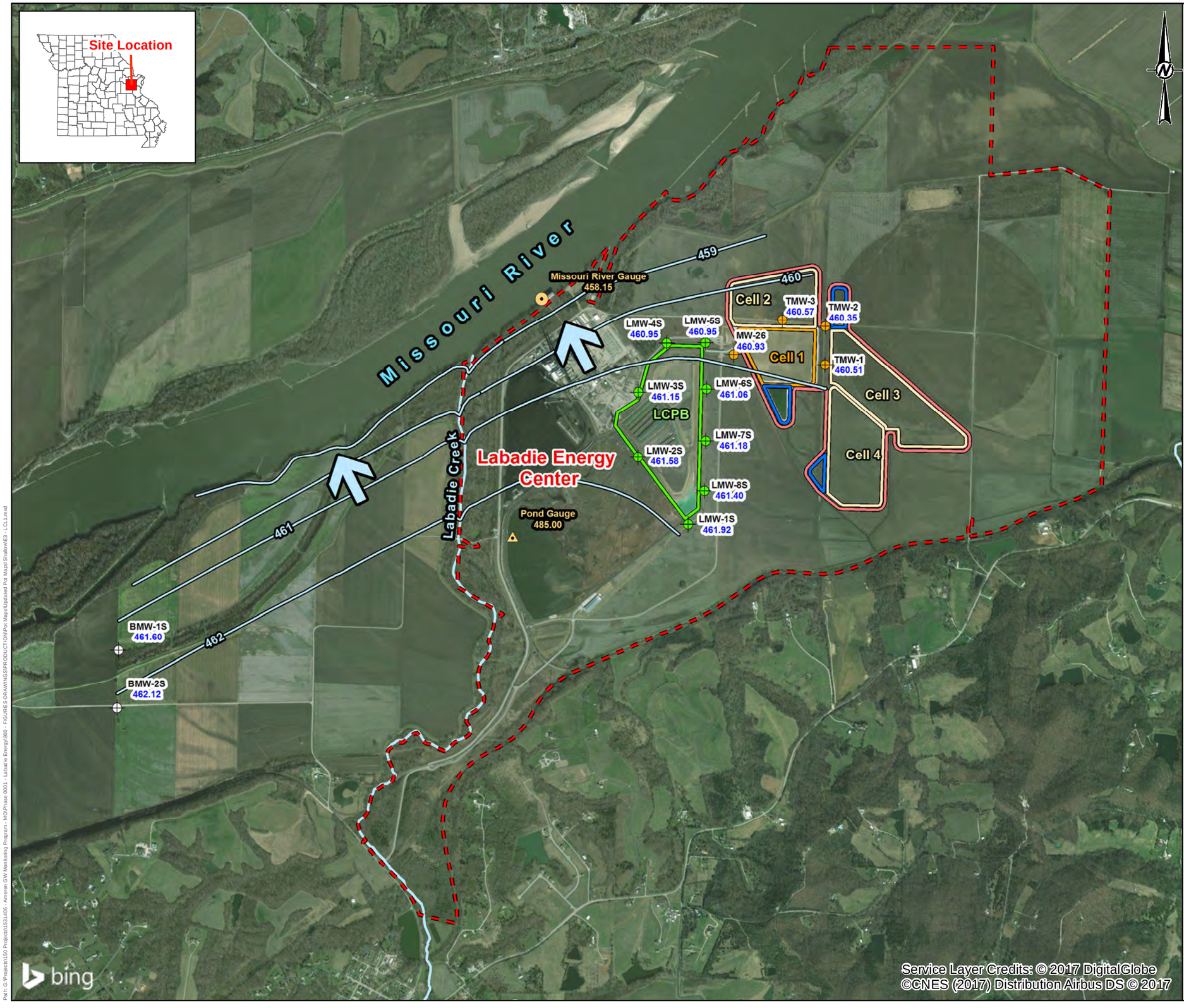


LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ & JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 3 - JULY 11, 2016

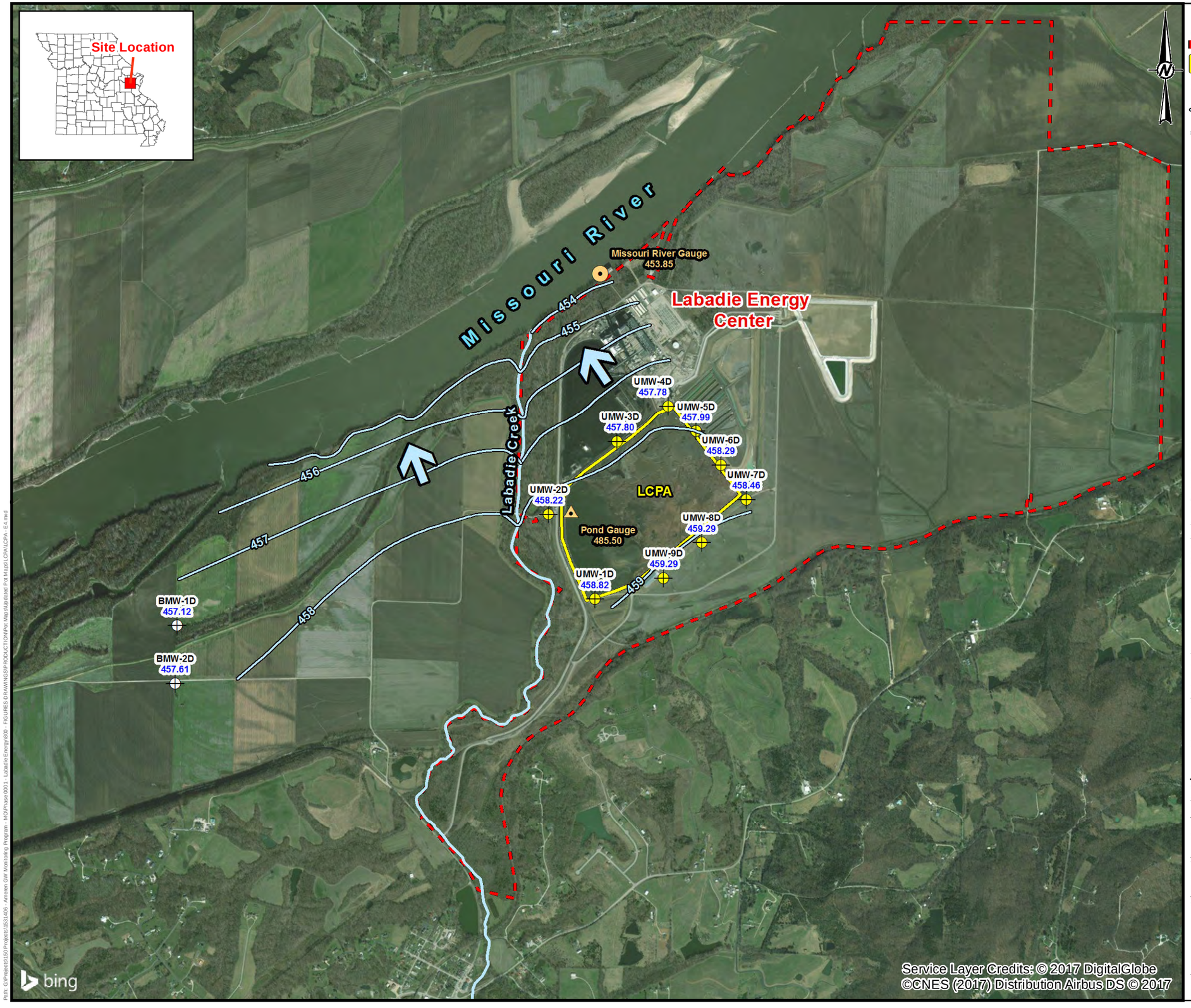
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-28
PREPARED	JS
DESIGN	JSI
REVIEW	RJF/JSI
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B6**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 1in

Path: G:\Projects\1560 Projects\15311405 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Plot Maps\Updated Plot Maps\Shallow\E3 - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 4 - SEPTEMBER 8, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-26
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B7**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

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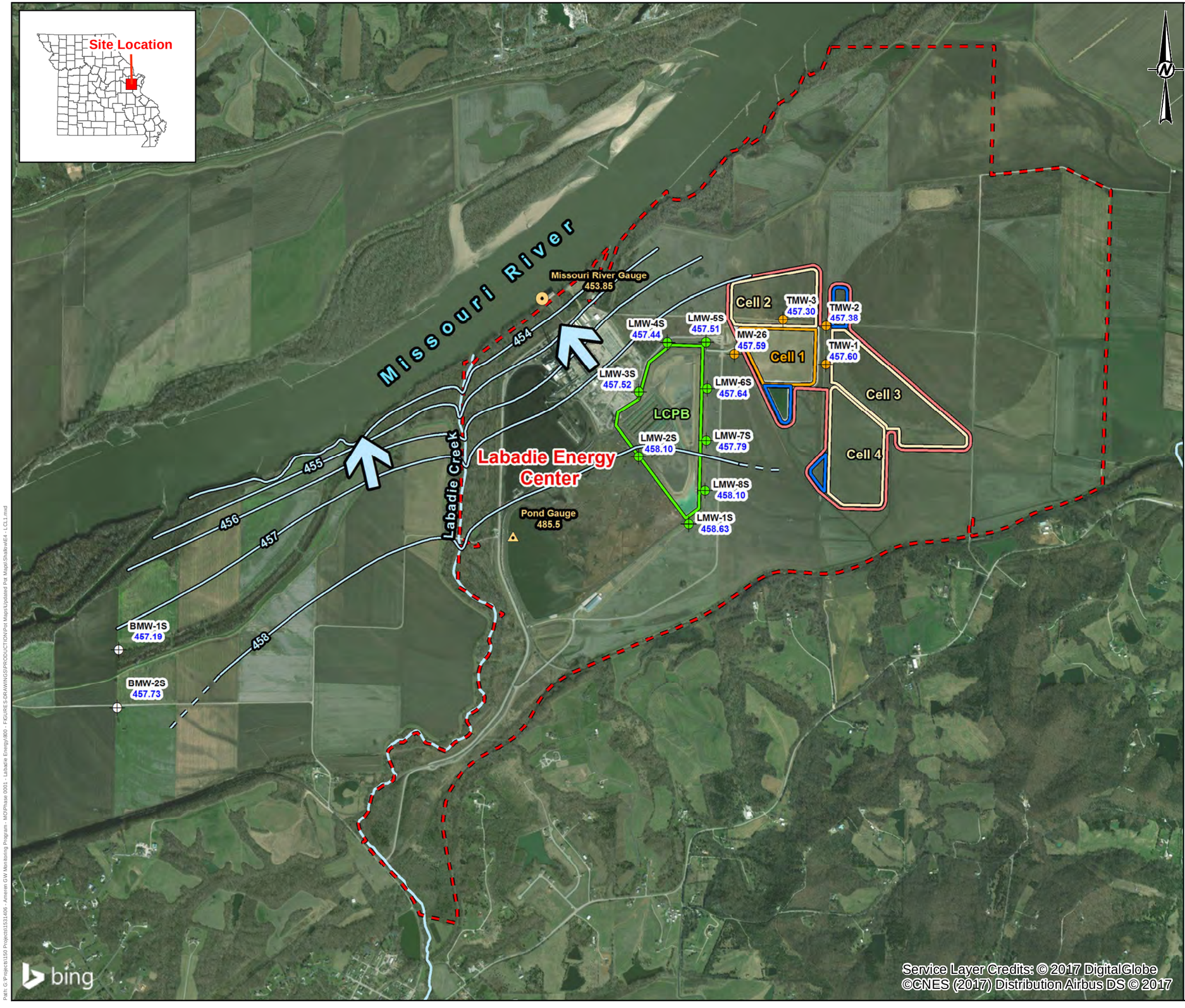


LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ & JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 4 - SEPTEMBER 8, 2016

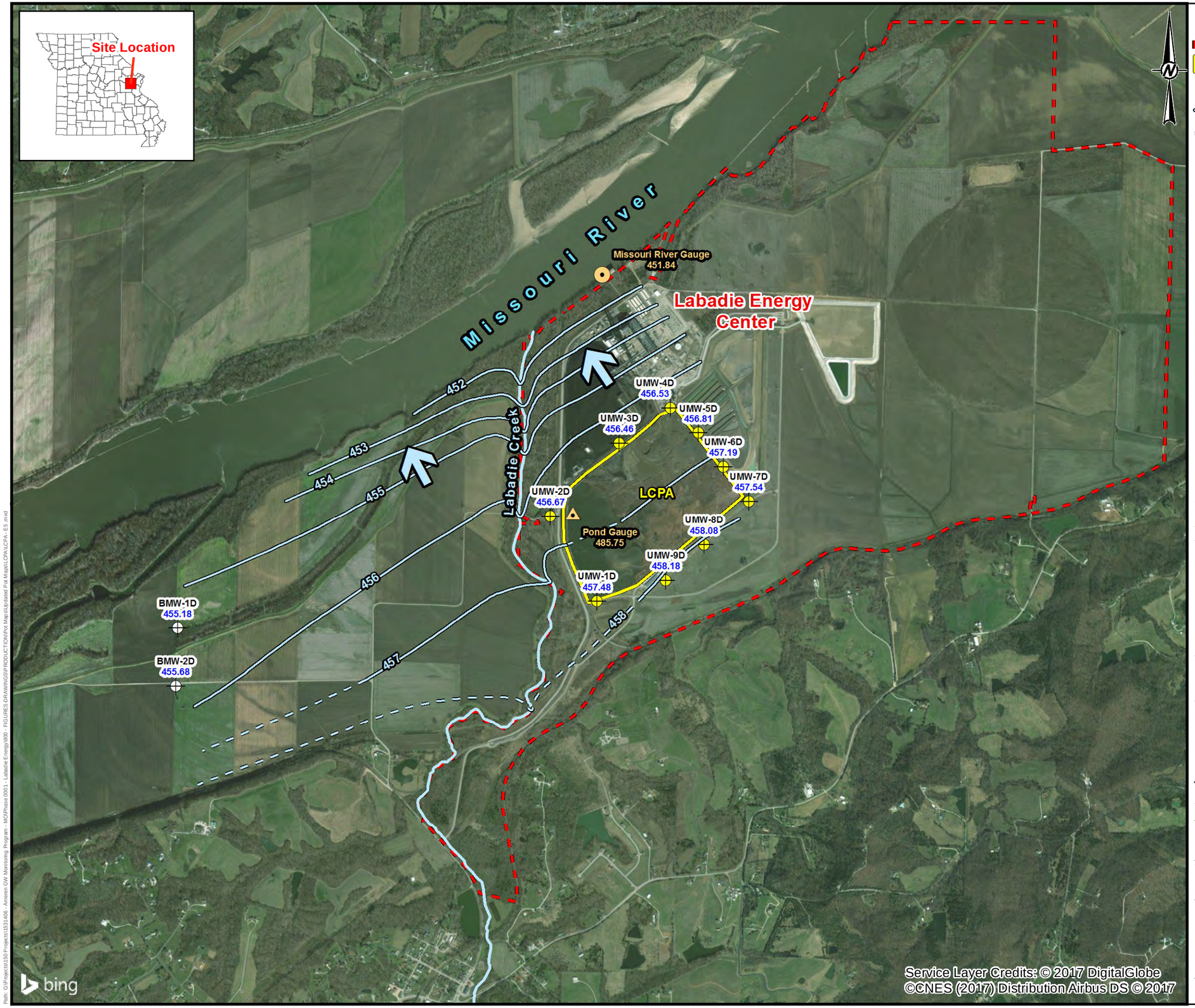
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-28
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B8**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: G:\Projects\1531\Projects\15311406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Plot Maps\Updated Plot Maps\Shallow\E4 - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 5001,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 5 - NOVEMBER 11, 2016

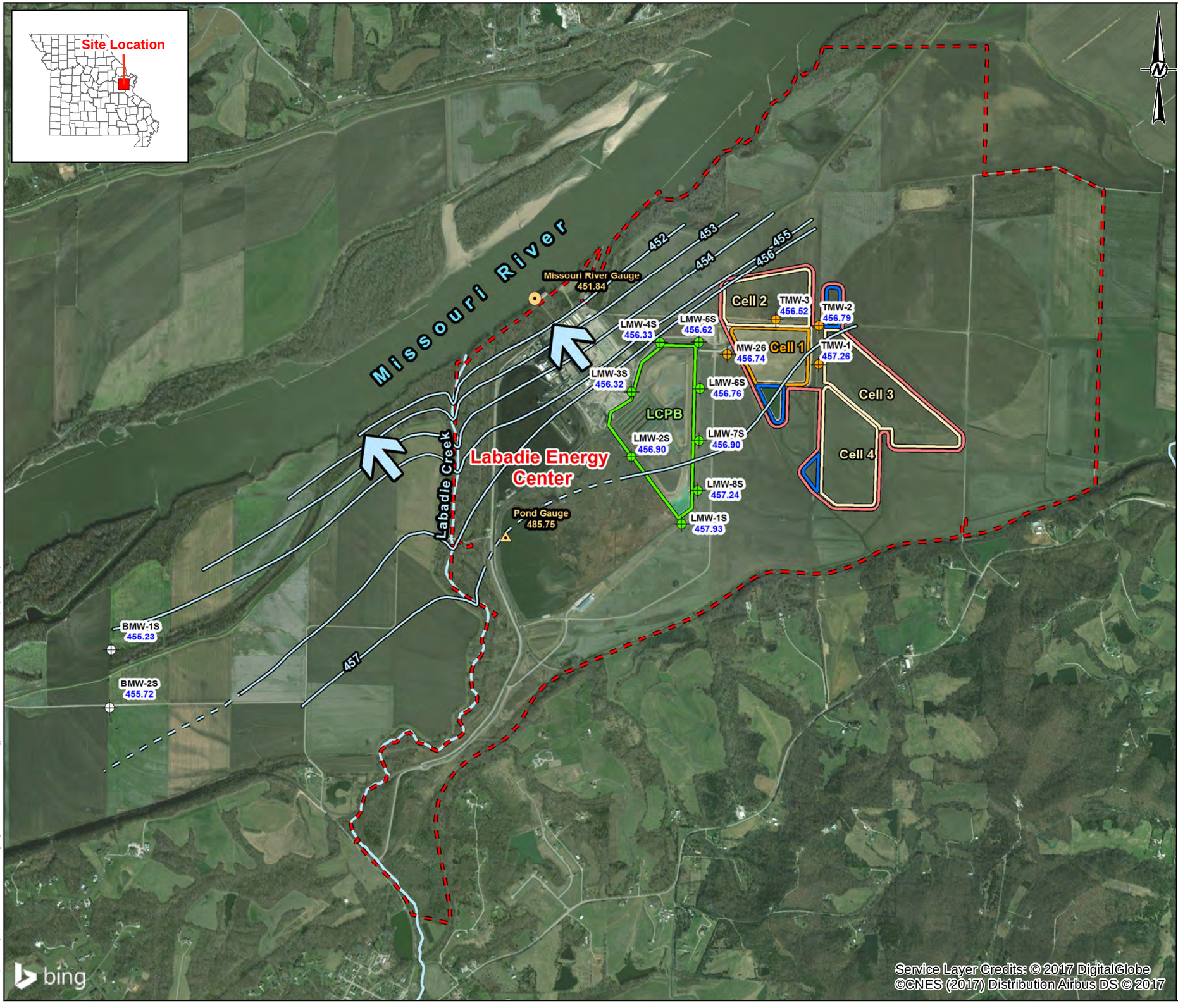
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-12-07
PREPARED	JSI
DESIGN	JSI
REVIEW	MSG
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001A | Rev. 0.0 | FIGURE **B9**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\153 Projects\153-406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - E5.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
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5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 5 - NOVEMBER 11, 2016

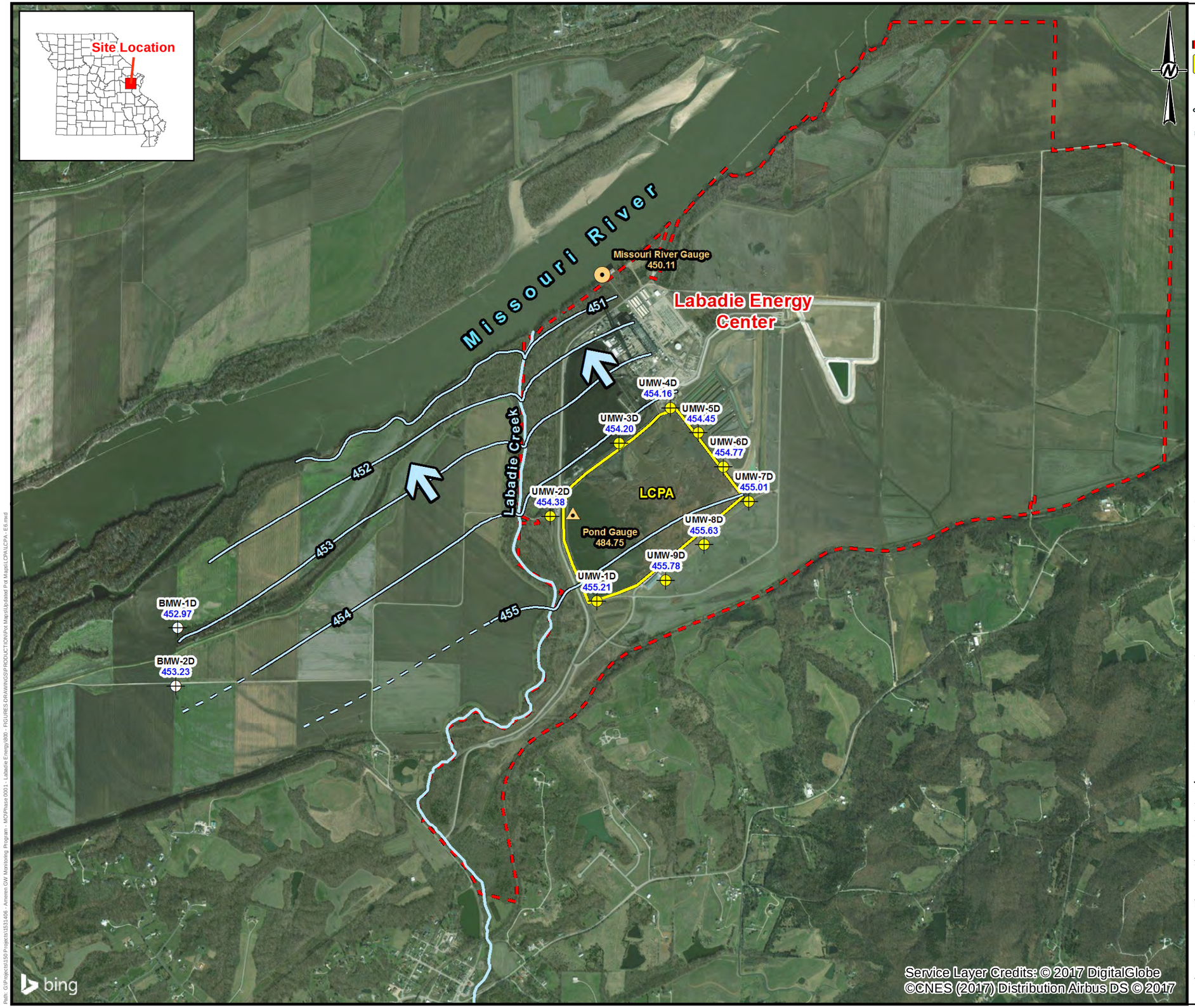
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-11-18
PREPARED	JSI
DESIGN	JSI
REVIEW	MSG
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B10**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 1in

Path: G:\Projects\153\Projects\15311406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Plot Maps\Updated Plot Maps\Shallow\E5 - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
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6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

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3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 6 - JANUARY 16, 2017

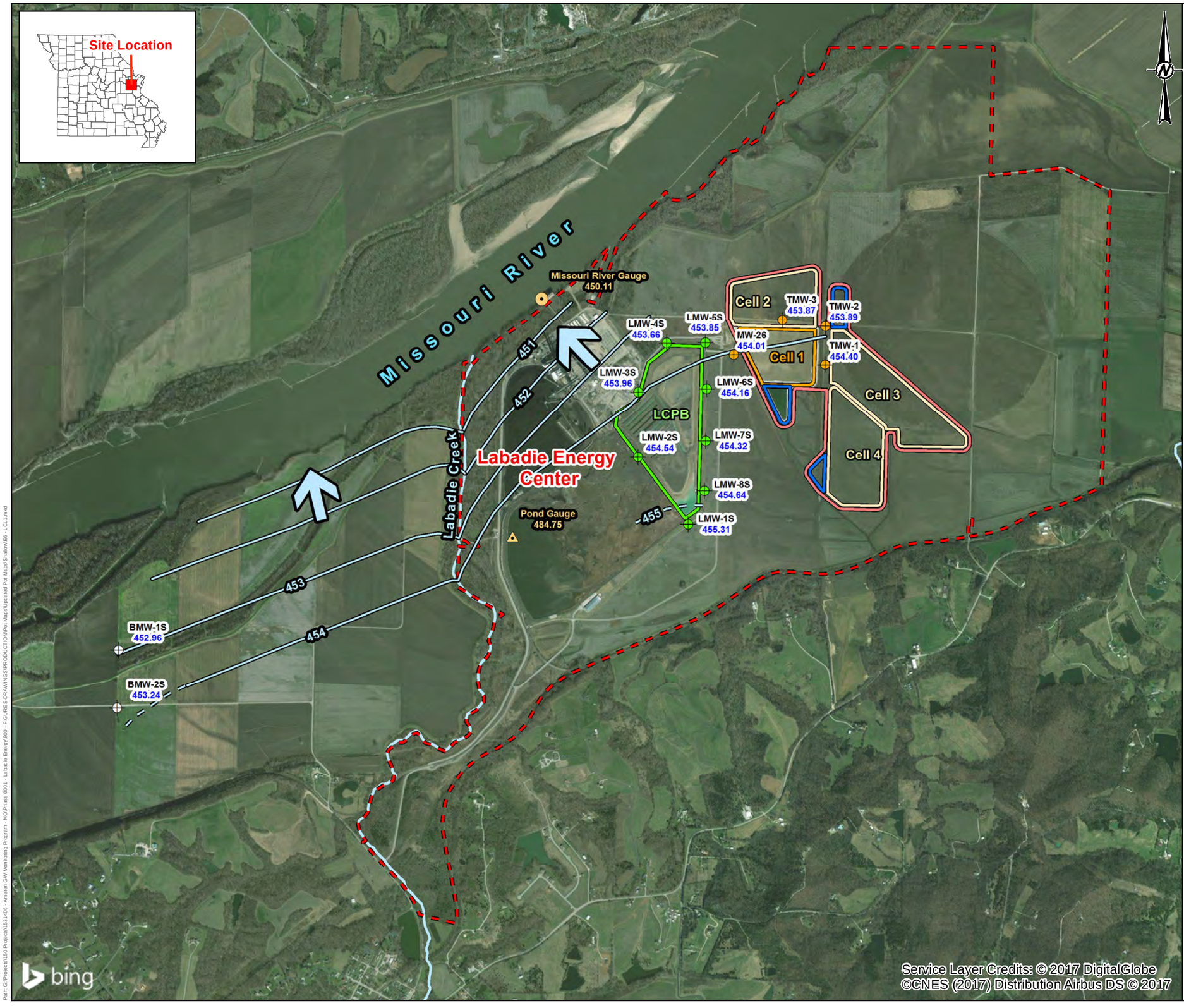
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
PREPARED	JS
DESIGN	JSI
REVIEW	BEF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B11**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - E6.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ & JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 6 - JANUARY 16, 2017

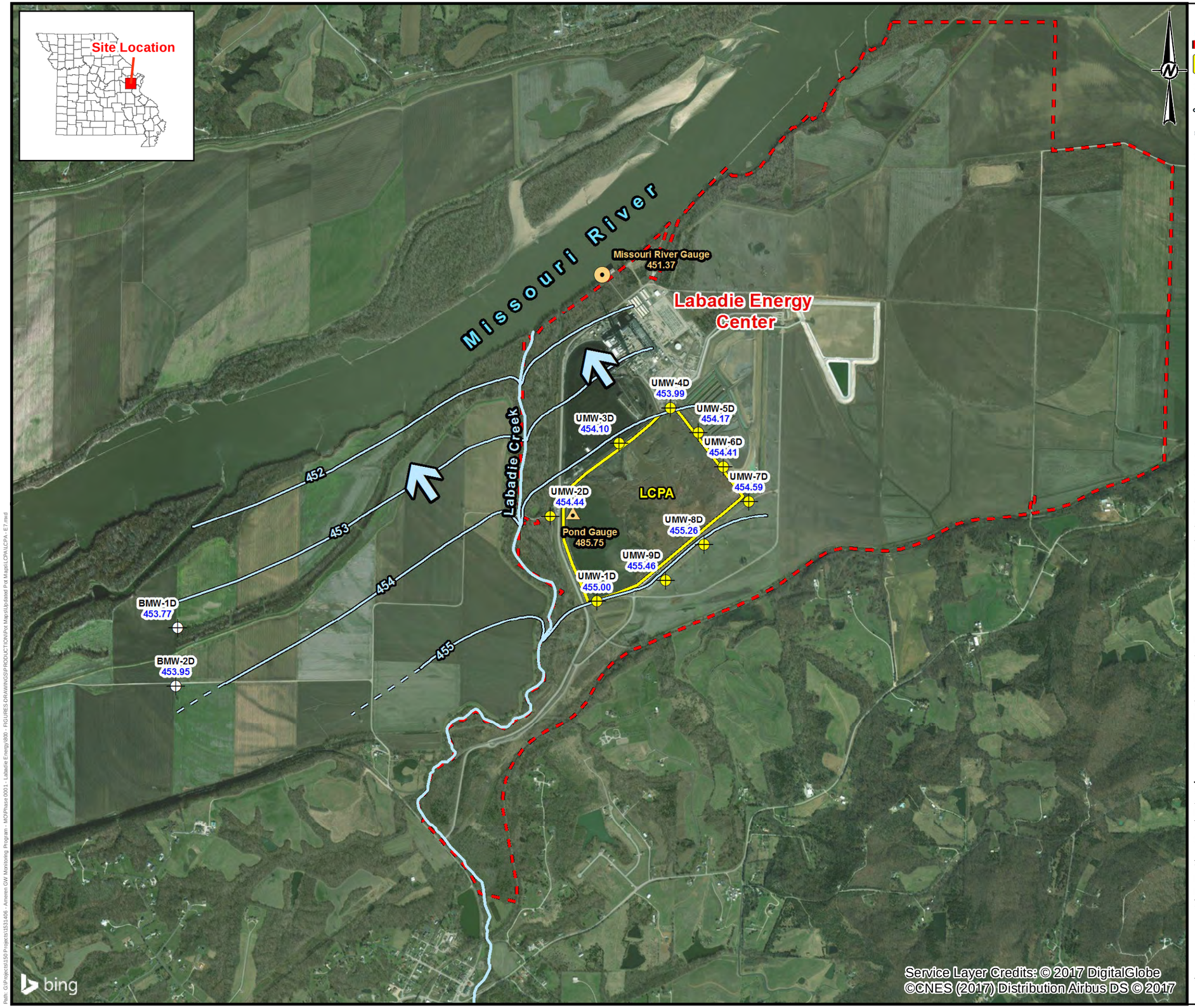
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
PREPARED	JS
DESIGN	JSI
REVIEW	BEF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001B	0.0	**B12**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: G:\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Plot Maps\Updated Plot Maps\ShallowE6 - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 7 - MARCH 1, 2017

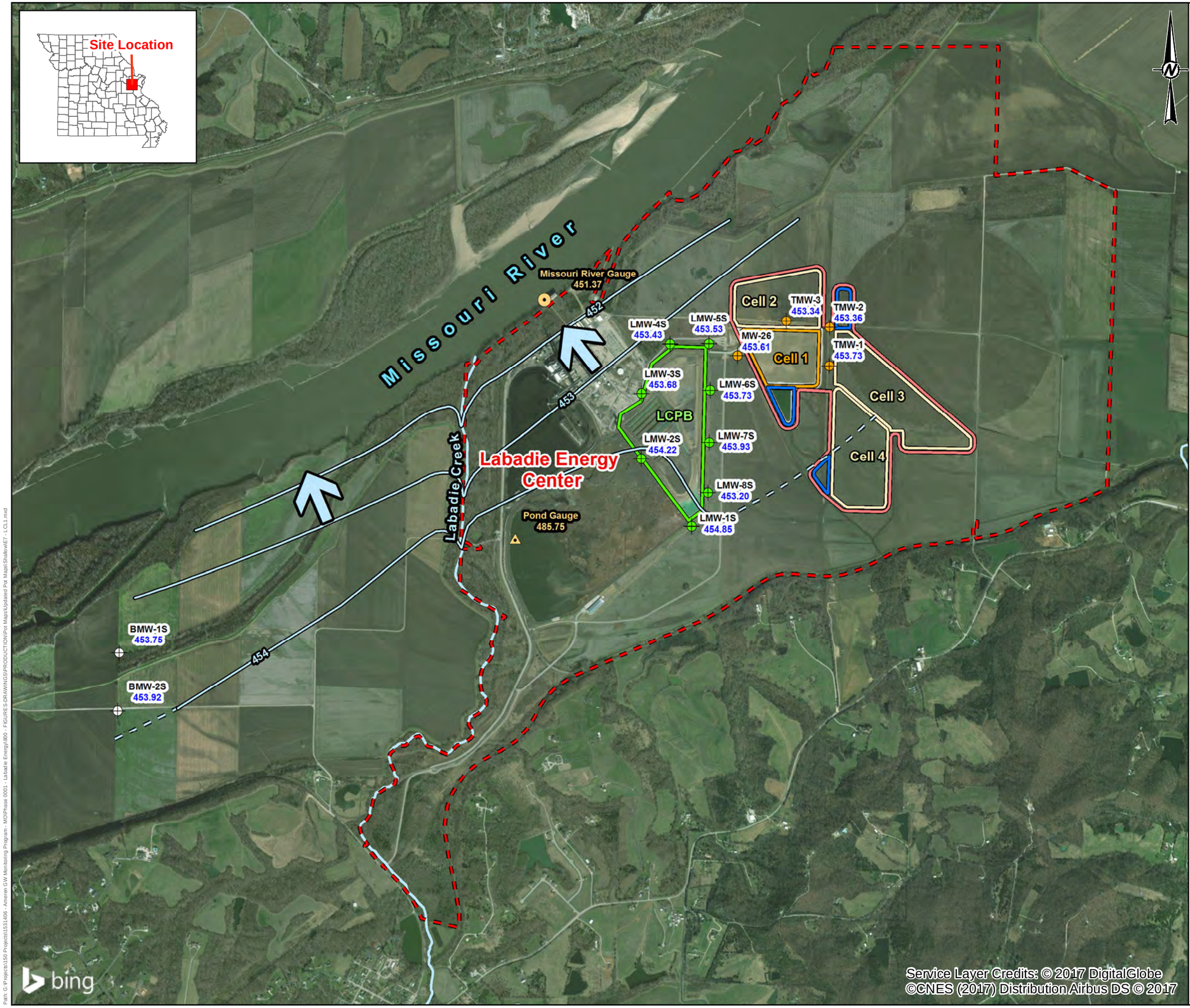
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-14
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B13**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - E7.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
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7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
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REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 7 - MARCH 1, 2017

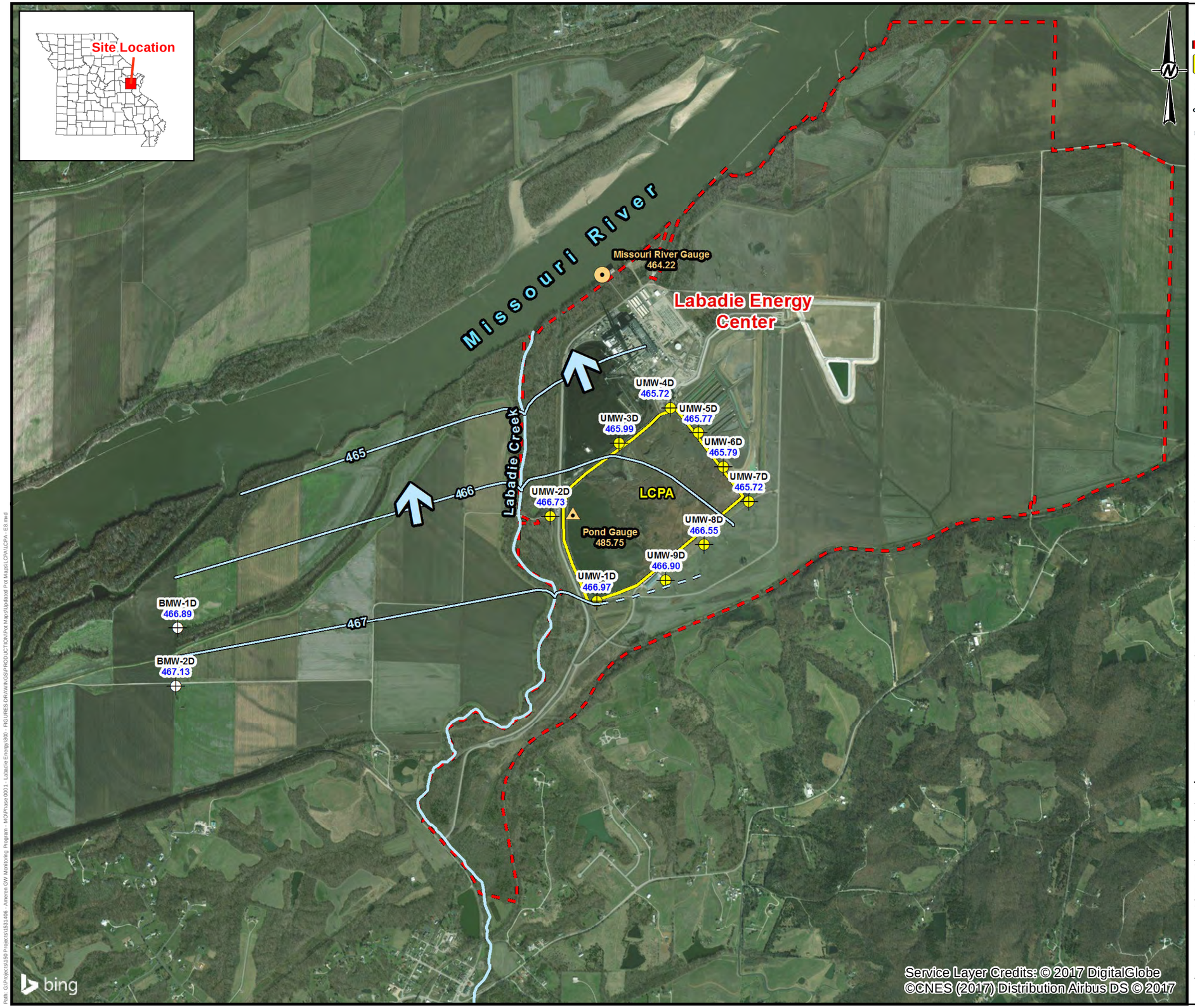
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-06-14
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B14**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: G:\Projects\1531\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\Shallow\ET - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
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6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

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3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 5001,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 8 - MAY 31, 2017

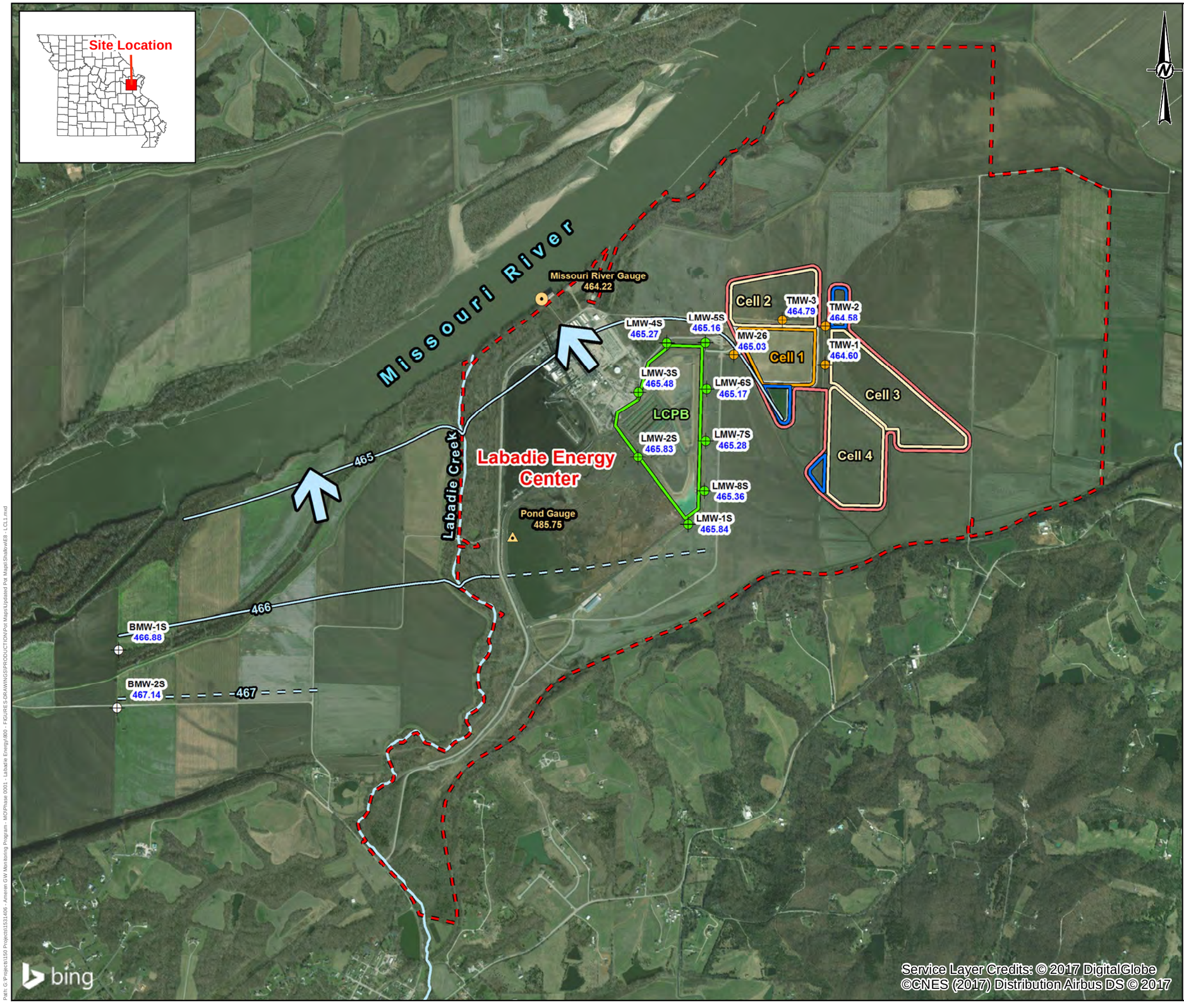
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-06-14
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B15**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\LCPA - EB.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
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7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

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2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 500 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 8 - MAY 31, 2017

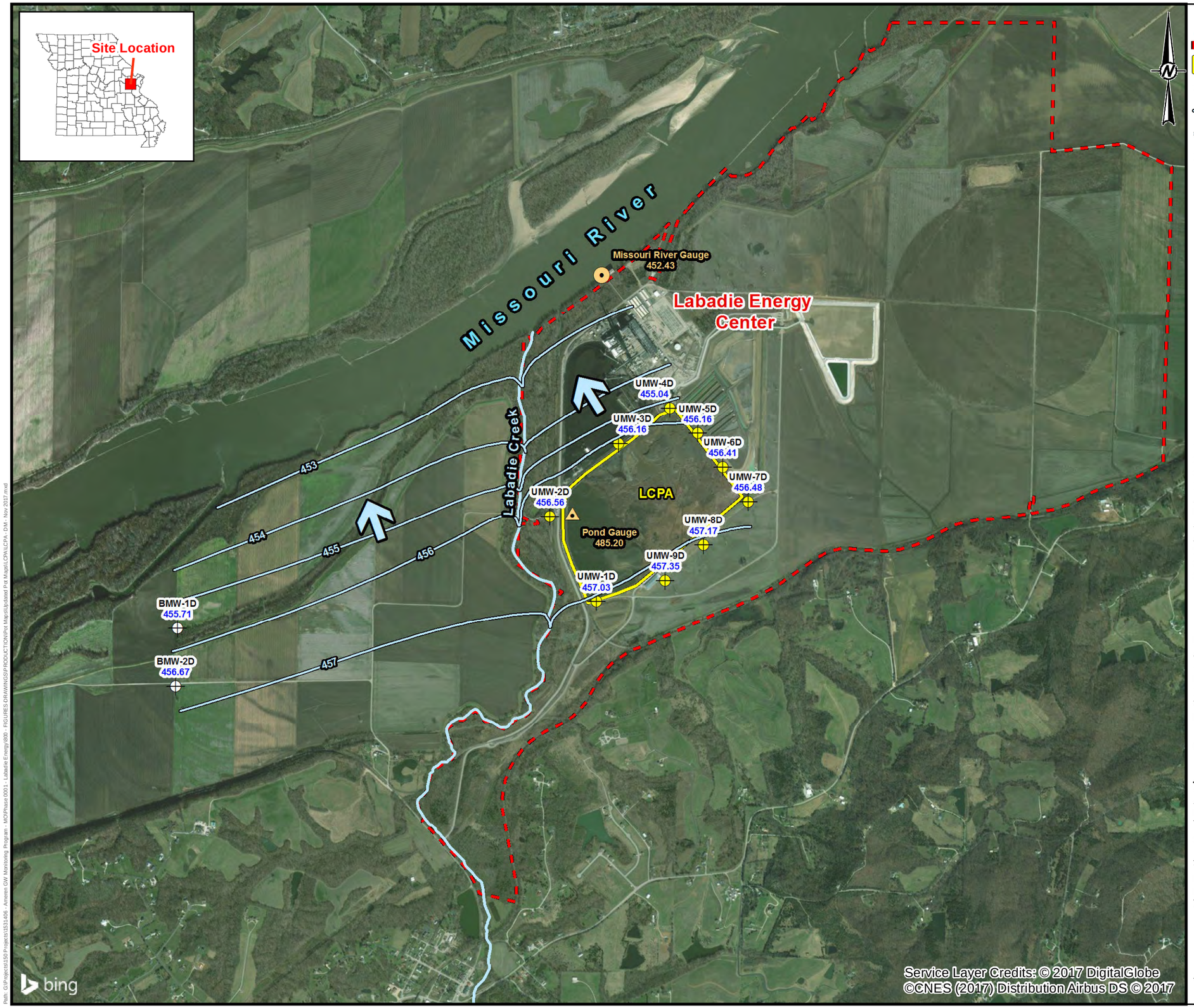
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-06-14
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001C	0.0	**B16**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

Path: G:\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Plot Maps\Updated Plot Maps\ShallowEB - LCL1.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- = = = Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
5. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
6. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

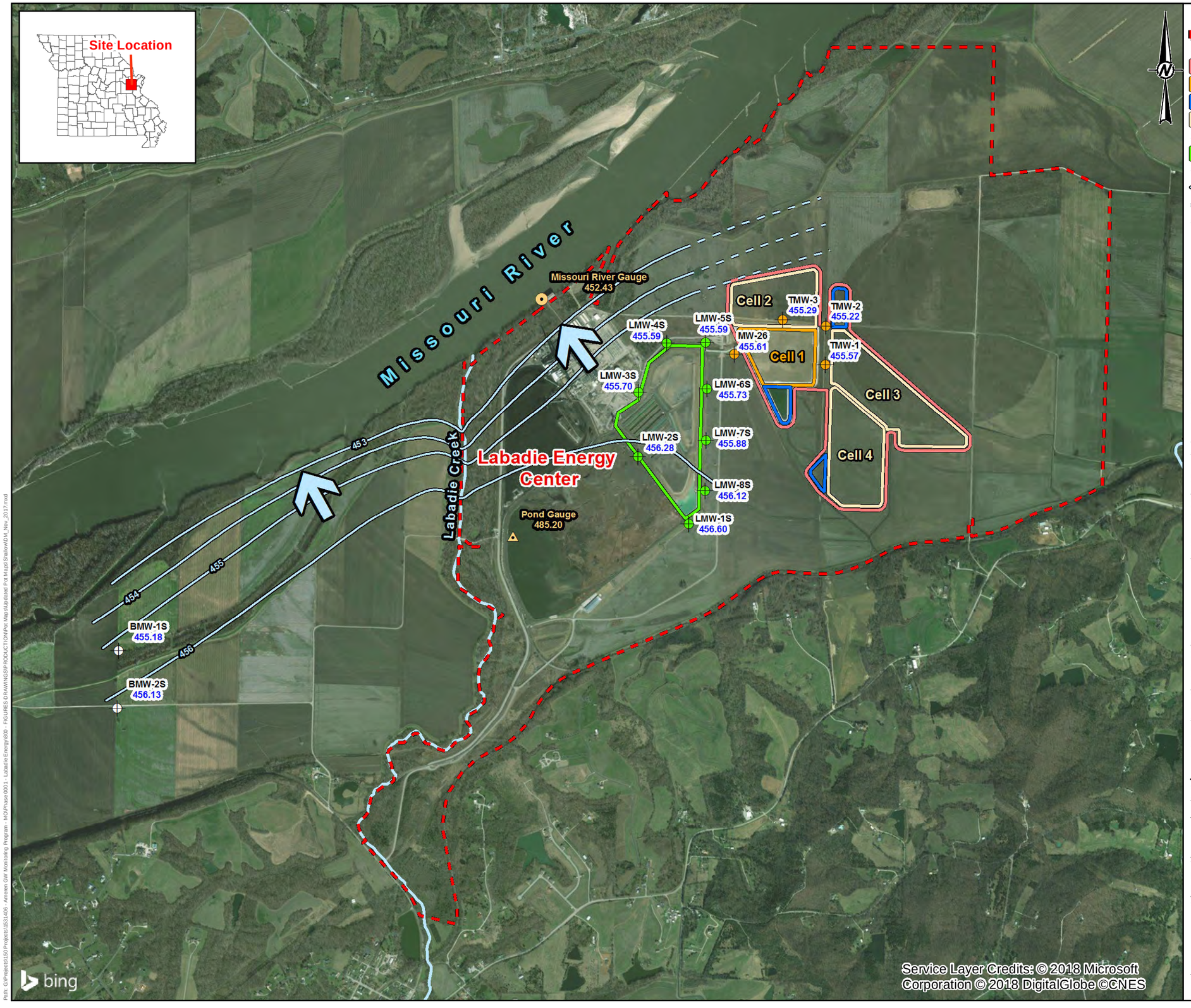
PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP
DETECTION MONITORING - NOVEMBER 7, 2017

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-11-17
PREPARED	RJF
DESIGN	JSI
REVIEW	JS/JSI
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001A	0.0	**B17**



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- Cell LCL1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
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5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 5001,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
DETECTION MONITORING EVENT - NOVEMBER 7, 2017

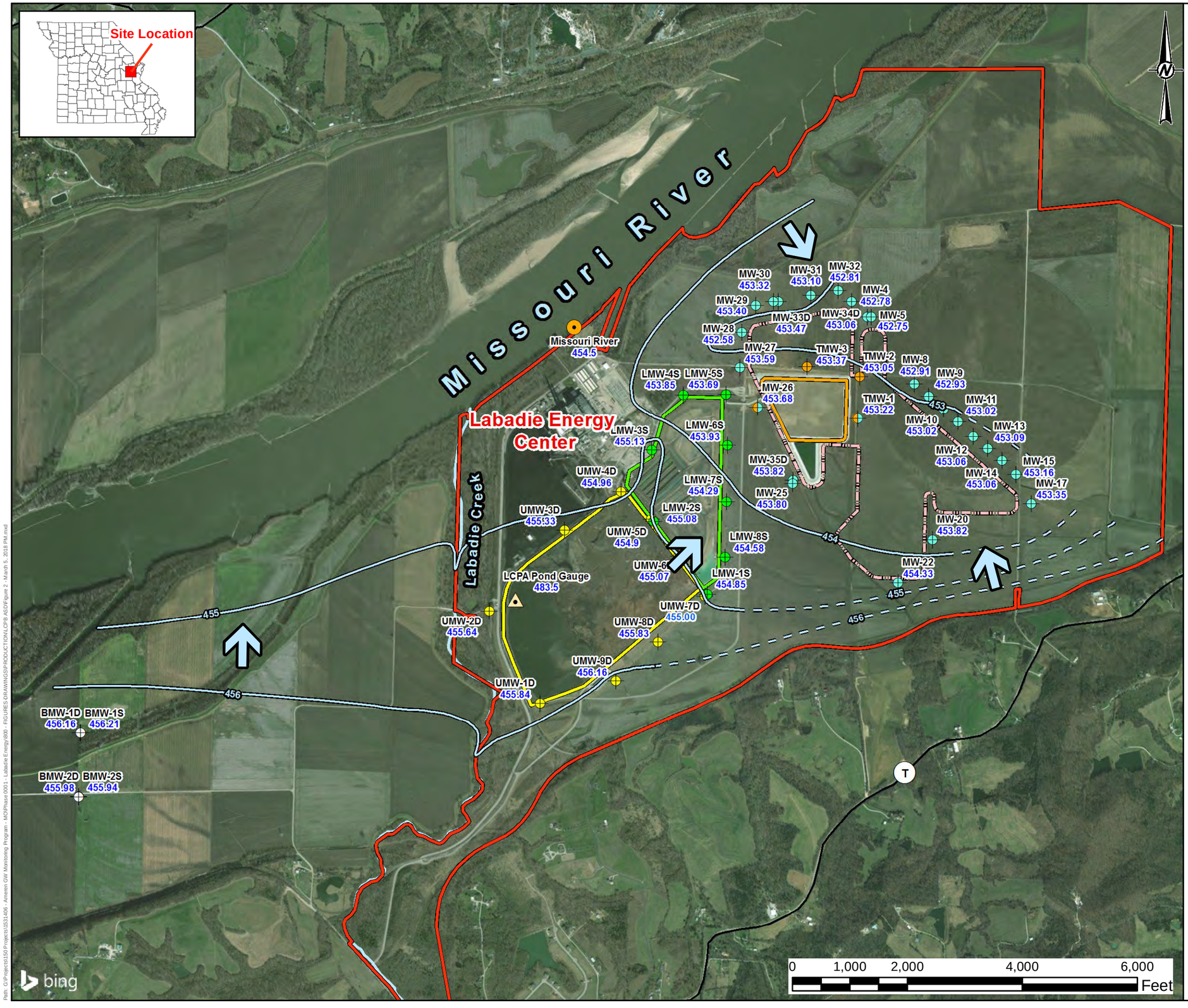
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-11-17
PREPARED	RJF
DESIGN	JSI
REVIEW	JS/JSI
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001B | Rev. 0.0 | FIGURE **B18**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\ShallowMDM_Nov_2017.mxd



LEGEND

- Labadie Energy Center Property Boundary

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Utility Waste Landfill (UWL)

- Proposed Future Fence Perimeter
- LCL1 - UWL Cell 1

Groundwater Sampling/Measurement Locations

- LCPA - Bottom Ash CCR Rule Surface Impoundment Monitoring Well
- LCPB - Fly Ash CCR Rule Surface Impoundment Monitoring Well
- Background CCR Rule Monitoring Well
- UWL CCR Rule Monitoring Well
- UWL Solid Waste Disposal Area Monitoring Well
- UWL CCR Rule and Solid Waste Disposal Area Monitoring Well
- Missouri River Gauge
- LCPA Pond Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) THE UTILITY WASTE LANDFILL (UWL) BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
3.) CCR - COAL COMBUSTION RESIDUALS.
4.) UWL - UTILITY WASTE LANDFILL.
5.) GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER ON MARCH 5, 2018.
6.) MW-18, MW-23 AND AW-1 GROUNDWATER ELEVATIONS NOT USED FOR POTENTIOMETRIC CONTOURING BECAUSE ELEVATIONS WERE NOT REPRESENTATIVE. VISUAL OBSERVATION NEAR ALL THREE LOCATIONS NOTED PONDED WATER AT THE SURFACE ADJACENT TO THE MONITORING WELL LOCATIONS.

REFERENCES

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) REITZ & JENS, INC. 2013. GROUNDWATER DETECTION MONITORING WELLS INSTALLATION REPORT. AMEREN MISSOURI, LABADIE ENERGY CENTER.
3.) REITZ & JENS, INC. 2014. ADDITIONAL GROUNDWATER DETECTION MONITORING WELLS INSTALLATION REPORT. AMEREN MISSOURI, LABADIE ENERGY CENTER.
4.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
LCPB - ALTERNATIVE SOURCE DEMONSTRATION

TITLE
MARCH 5, 2018 POTENTIOMETRIC SURFACE MAP

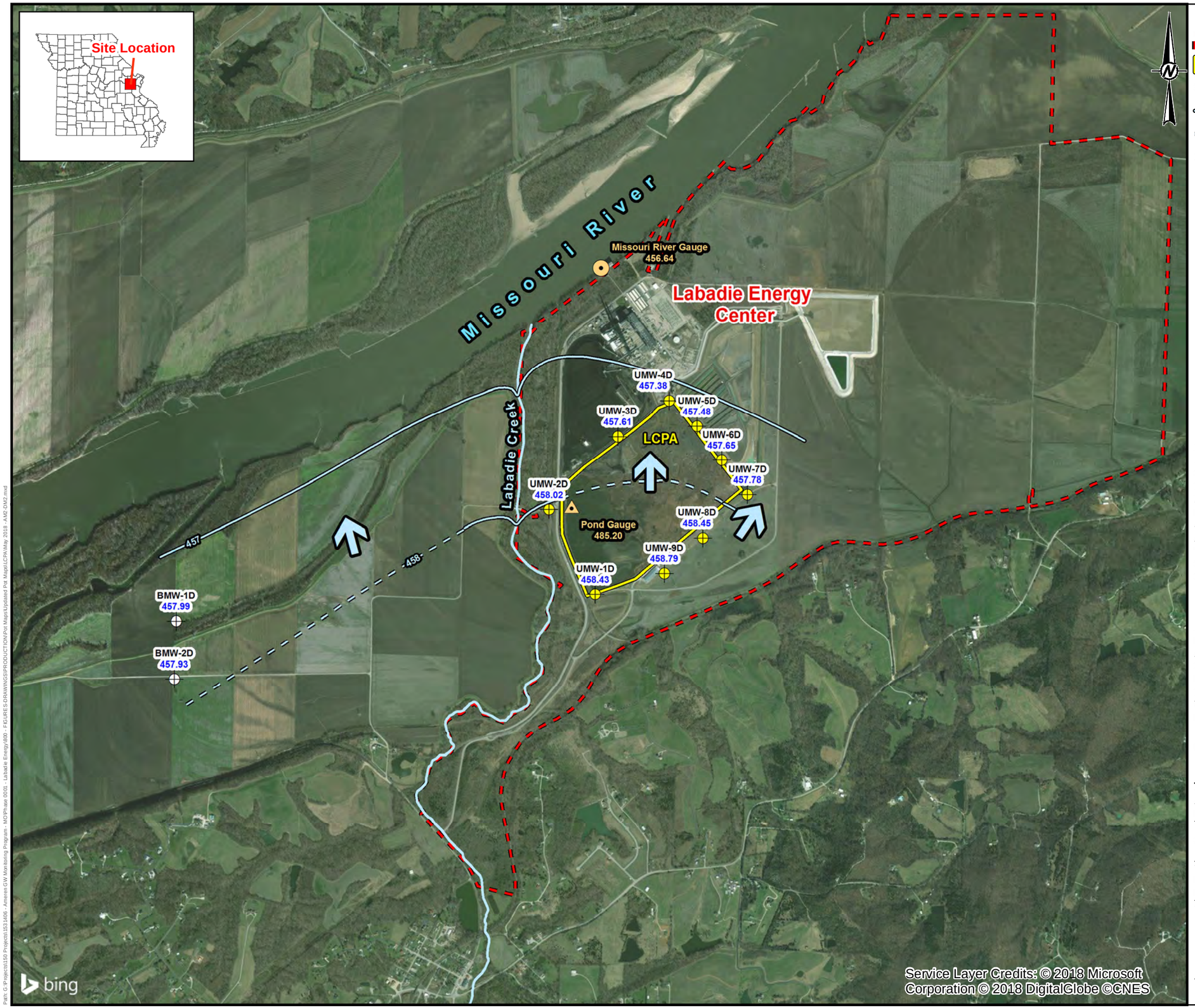
CONSULTANT
GOLDER

YYYY-MM-DD	2018-03-28
PREPARED	JSI
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406 | Rev. 0.0 | FIGURE **B19**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 0 1in

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\LCPB ASD\Figure 2 - March 5, 2018 PM.mxd



LEGEND

- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Background Monitoring Well
- LCPA - Bottom Ash Surface Impoundment Monitoring Well
- Missouri River Gauge
- LCPA - Bottom Ash Surface Impoundment
- Groundwater Flow Direction

NOTES

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REFERENCES

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3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPA POTENTIOMETRIC SURFACE MAP MAY 21, 2018

CONSULTANT
GOLDER

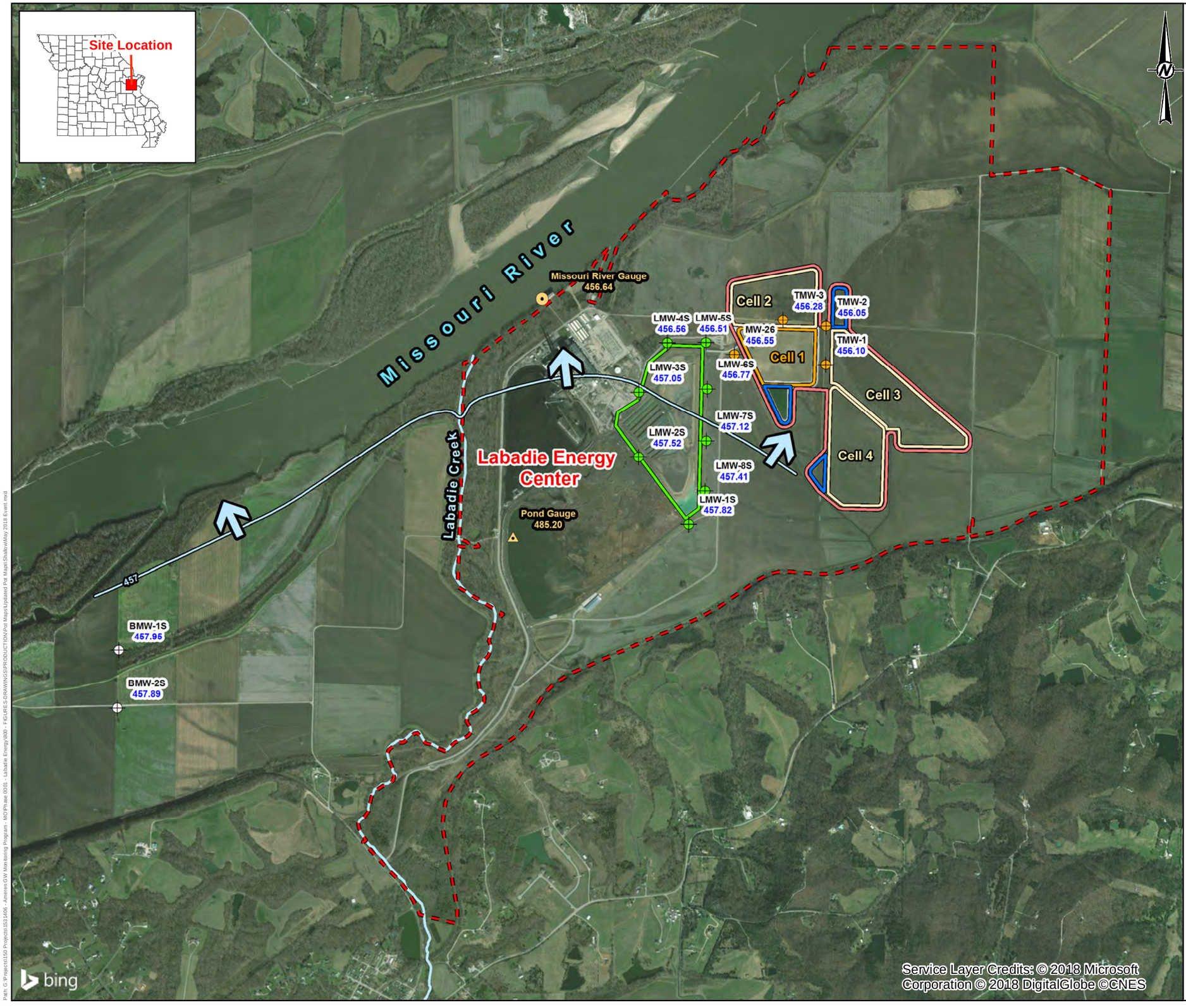
YYYY-MM-DD	2018-06-05
PREPARED	RJF
DESIGN	JSI
REVIEW	EMS
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0001 | Rev. 0.0 | FIGURE **B20**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
1in 0

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\LCPA\May 2018 - AM2-DM2.mxd

AMEREN_00002724



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Fence Perimeter
- LCL1 - Utility Waste Landfill Cell 1
- Proposed Stormwater Pond
- Proposed Future Cell

Surface Impoundment

- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- LCPB Fly Ash Surface Impoundment Monitoring Well
- Background Monitoring Well
- UWL Monitoring Well
- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ & JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.
4. REITZ & JENS, INC. 2014. ADDITIONAL GROUND WATER DETECTION MONITORING WELLS INSTALLATION REPORT.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
LCPB POTENTIOMETRIC SURFACE MAP
MAY 21, 2018

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-06
PREPARED	RJF
DESIGN	JSI
REVIEW	EMS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0001	0.0	**B21**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

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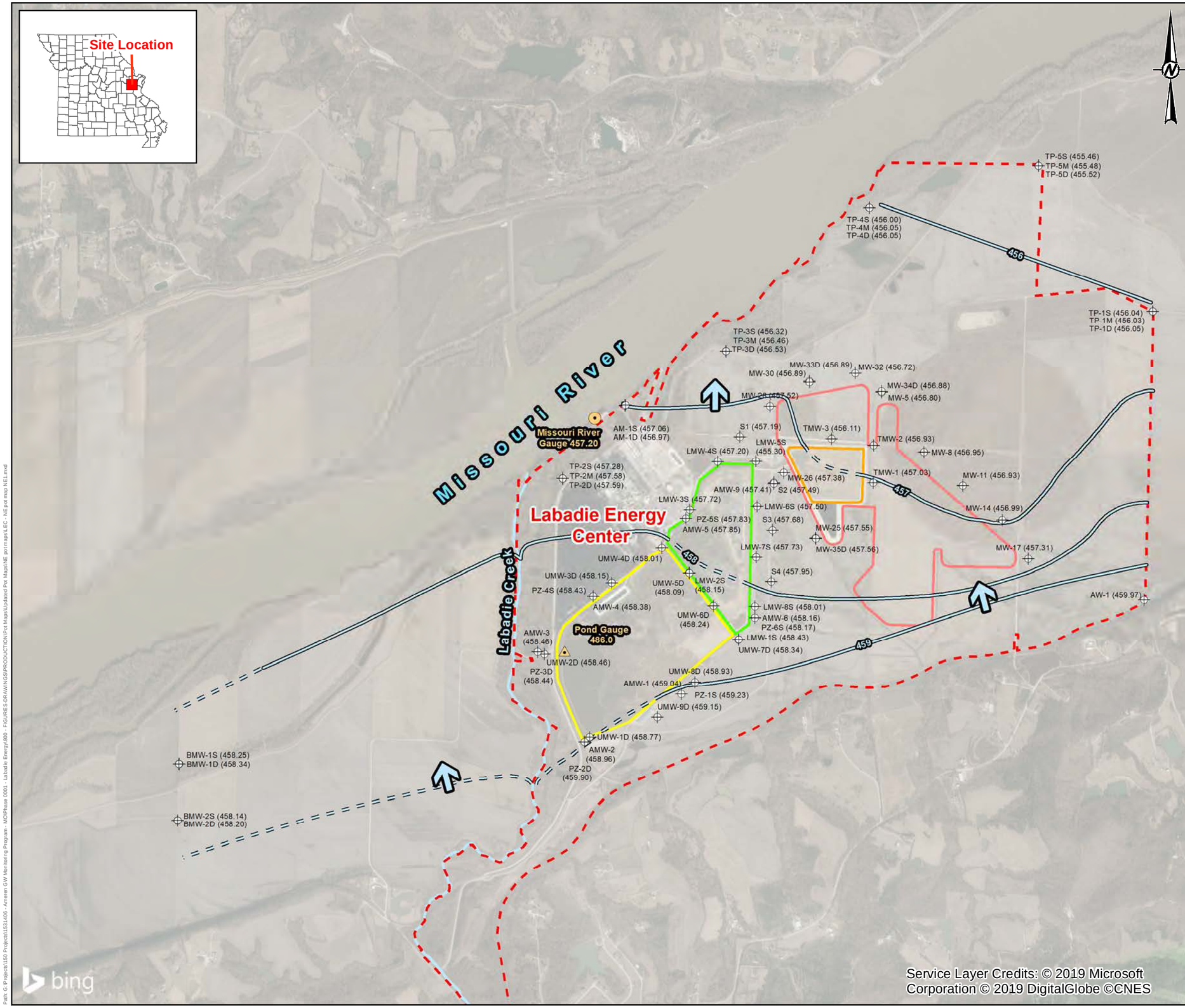


LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Utility Waste Landfill Cell LCL1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Well or Piezometer

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. LMW-5S WAS NOT USED IN POTENTIOMETRIC SURFACE CONTOURING.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000

Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
JUNE 25, 2018 POTENTIOMETRIC SURFACE MAP

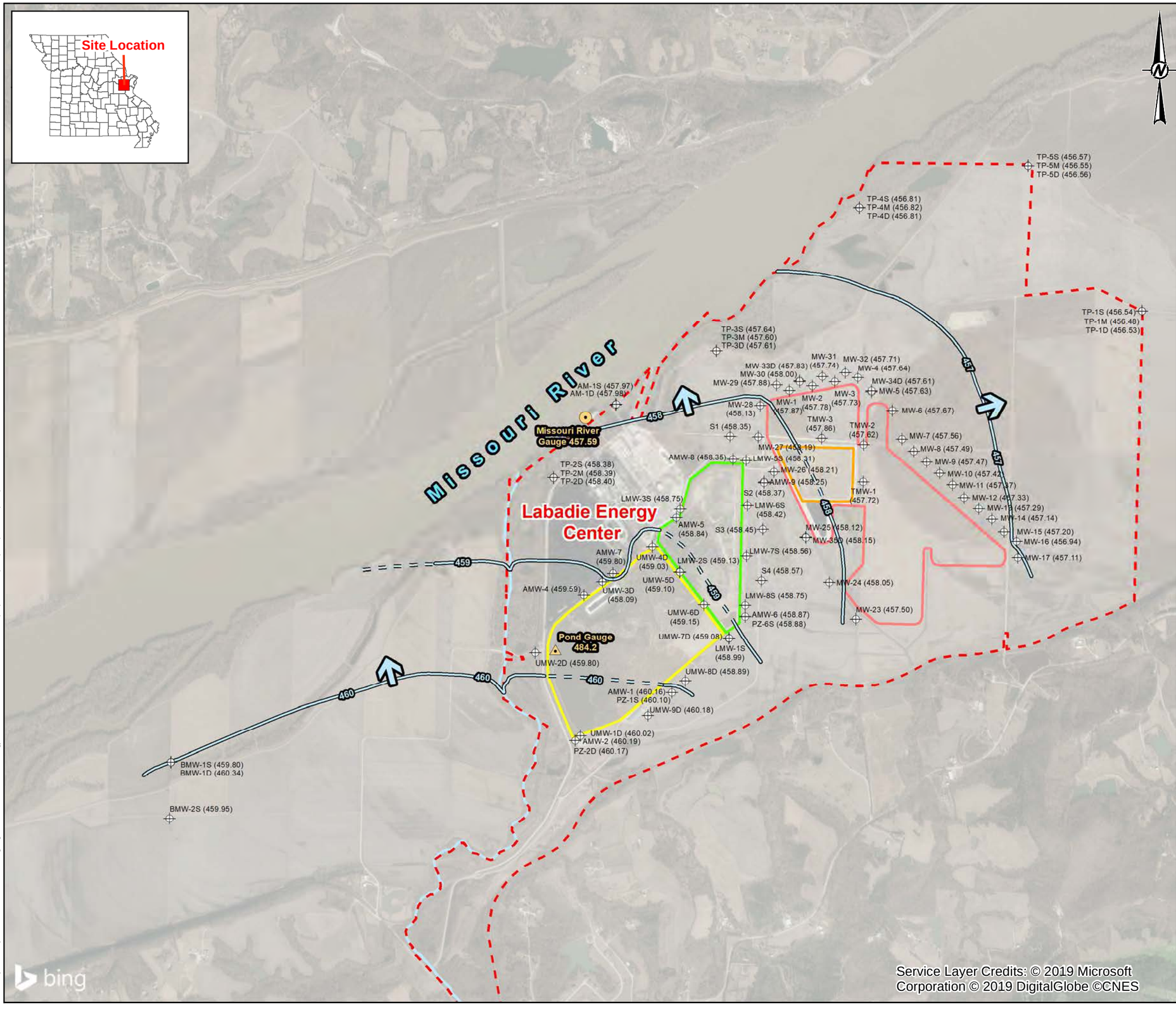
CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-24
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406 | Rev. 0.0 | FIGURE **B22**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map NE1.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Cell LCL1 - UWL Cell 1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Well or Piezometer

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. MW-30 AND UMW-8D WAS NOT USED IN POTENTIOMETRIC SURFACE CONTOURING.
8. BMW-2D WATER LEVEL WAS NOT INCLUDED IN WATER LEVEL MEASUREMENTS DUE TO DAMAGE TO THE WELL.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000

Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
JULY 24, 2018 POTENTIOMETRIC SURFACE MAP

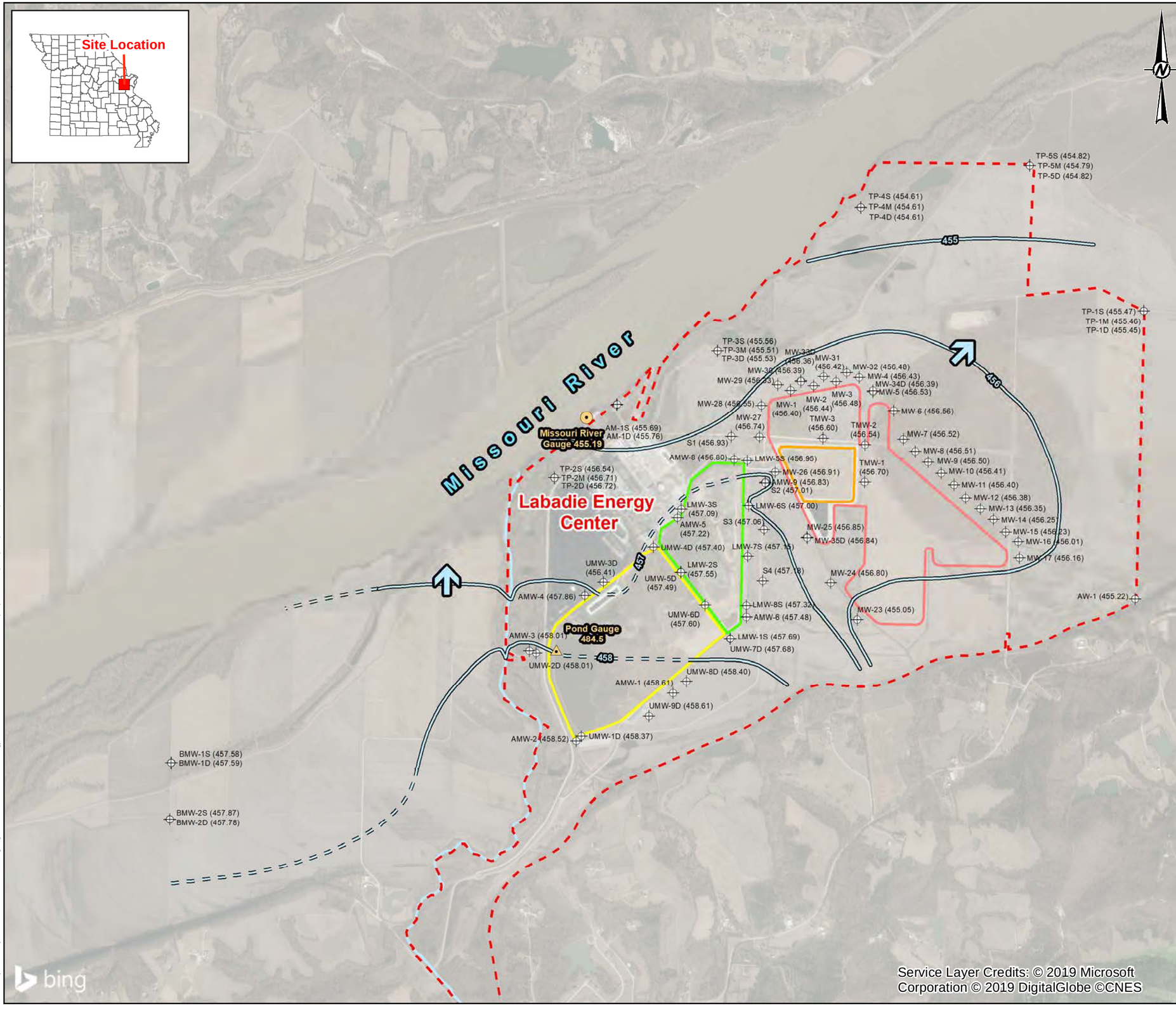
CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-31
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406
Rev. 0.0
FIGURE **B23**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map NE2.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Cell LCL1 - UWL Cell 1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Wells or Piezometers

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
AUGUST 22, 2018 POTENTIOMETRIC SURFACE MAP

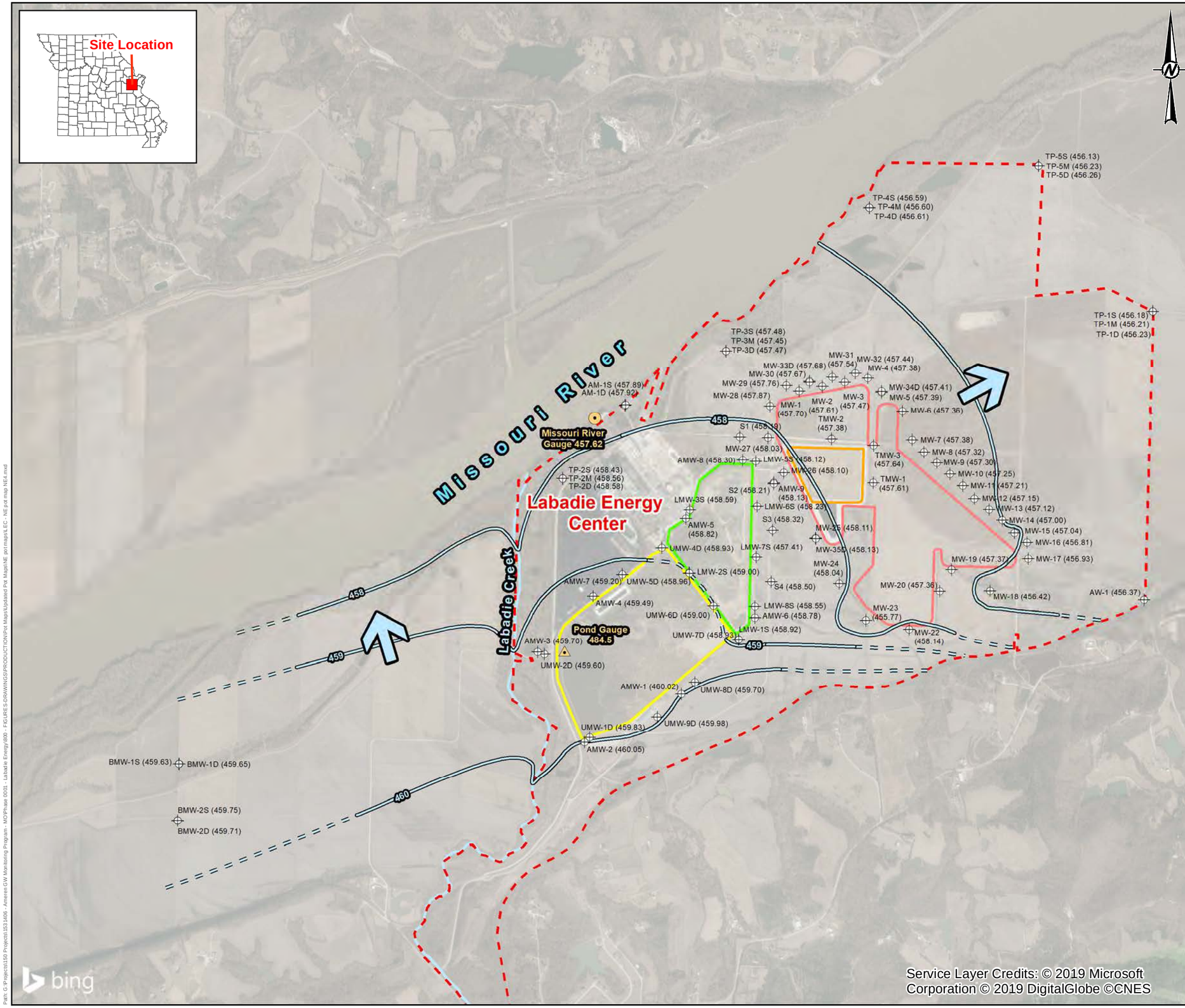
CONSULTANT
GOLDER

YYYY-MM-DD	2018-08-31
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406
Rev. 0.0
FIGURE **B24**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in

Path: G:\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map NE3.mxd



LEGEND

Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

Proposed Final UWL Fence Perimeter

Cell LCL1 - UWL Cell 1

Surface Impoundments

LCPA - Bottom Ash Surface Impoundment

LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

Monitoring Well or Piezomter

Surface Water Elevation Measurement Location

Missouri River Gauge

LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

Groundwater Elevation Contour (FT MSL)

Inferred Groundwater Elevation Contour (FT MSL)

Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. MONITORING WELLS LMW-7S AND MW-23 NOT USED FOR POTENTIOMETRIC SURFACE CONTOURING.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
SEPTEMBER 27, 2018 POTENTIOMETRIC SURFACE MAP

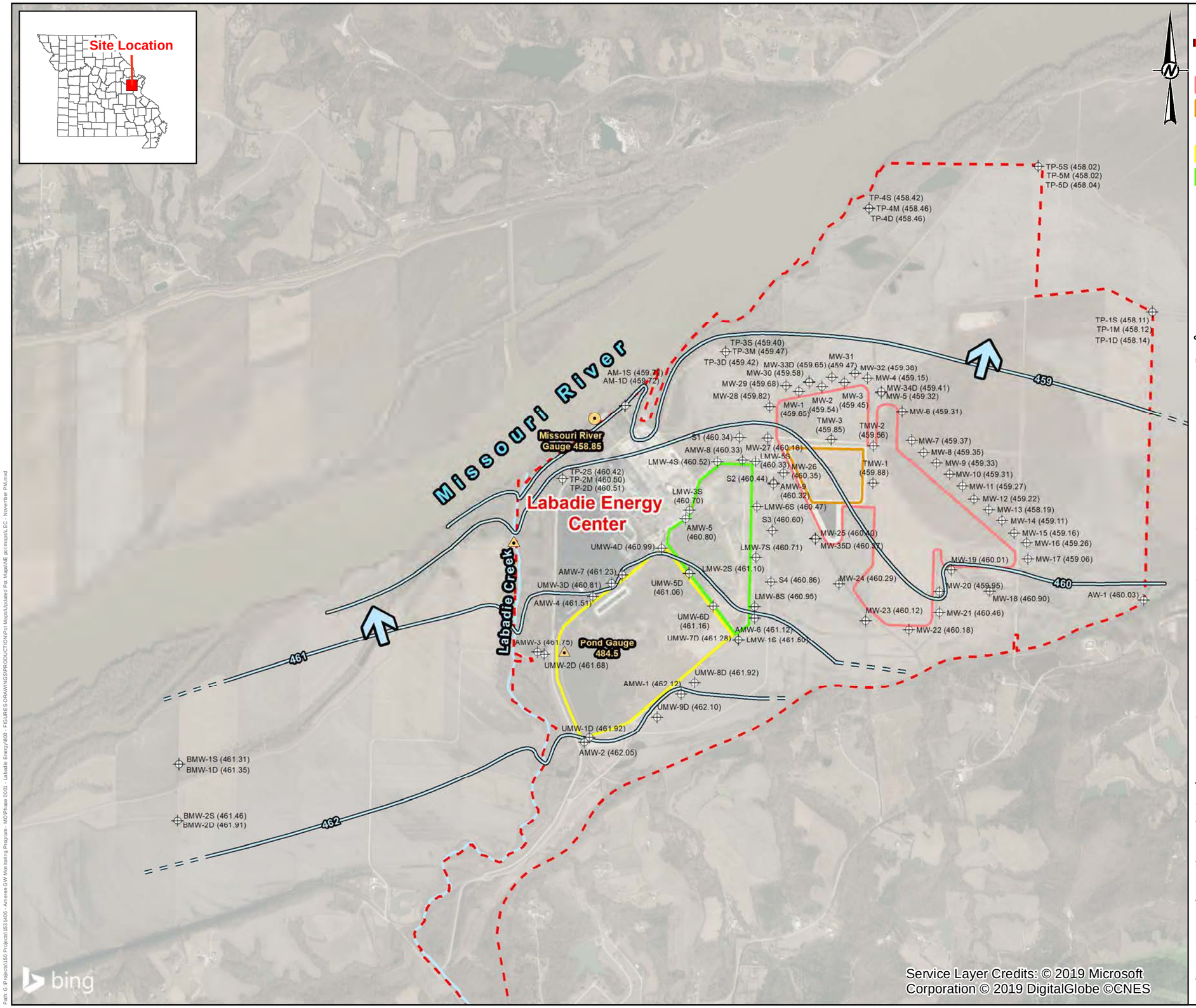
CONSULTANT
GOLDER

YYYY-MM-DD	2018-10-10
PREPARED	JSI
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406 | Rev. 0.0 | FIGURE **B25**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in

Path: G:\Projects\153 Projects\153-1406 - Ameren\ GW Monitoring Program - MO\Phase 0001 - Labadie Energy\1800 - FIGURES-DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map NEA.mxd



LEGEND

Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Utility Waste Landfill Cell LCL1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Well or Piezometer

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. MONITORING WELL MW-13 WAS NOT USED FOR POTENTIOMETRIC SURFACE CONTOURING

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
NOVEMBER 7, 2018 POTENTIOMETRIC SURFACE MAP

CONSULTANT
GOLDER

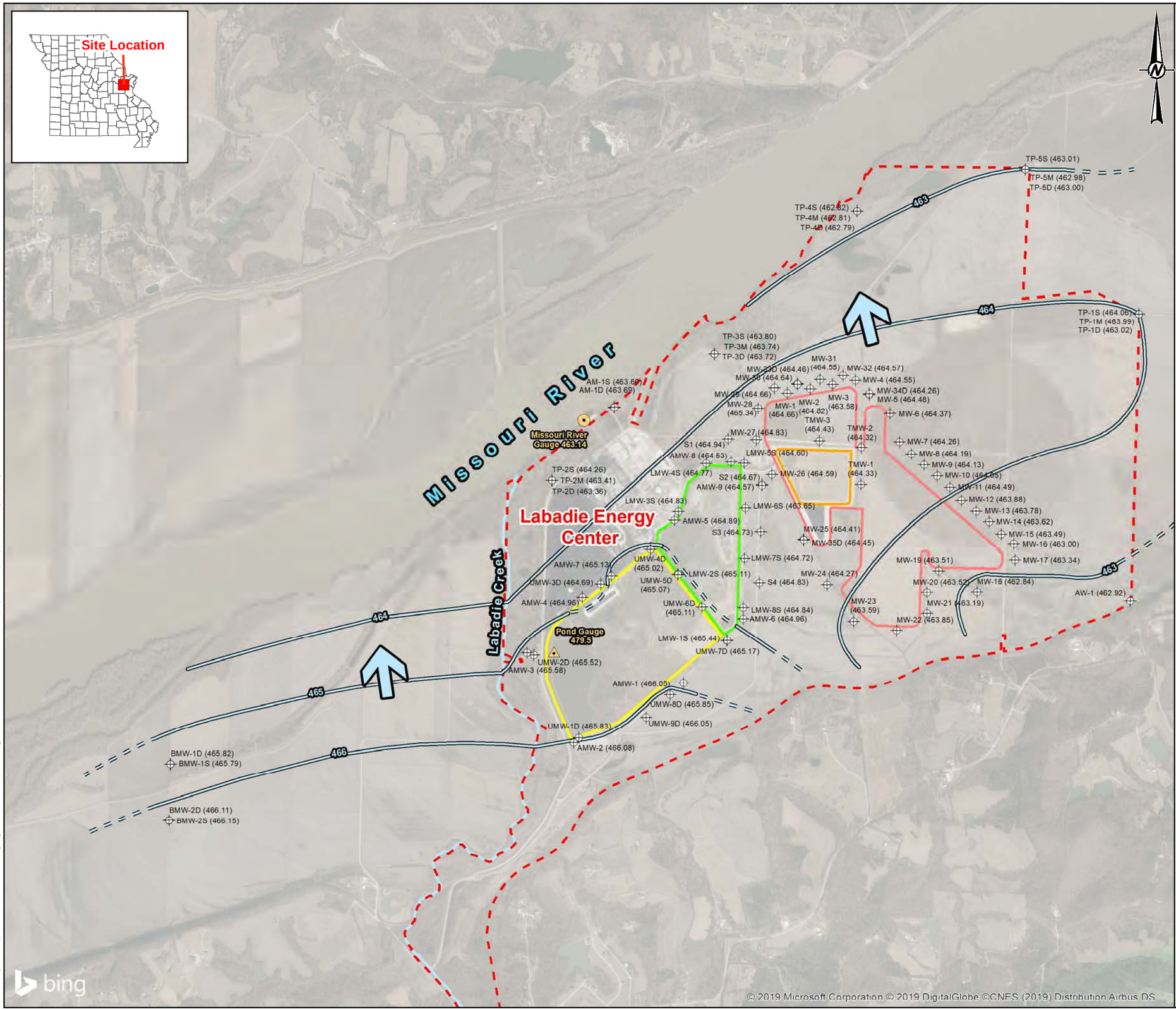
YYYY-MM-DD	2018-10-10
PREPARED	JSI
DESIGN	JSI
REVIEW	JAP
APPROVED	MNH

PROJECT No.
153-1406

FIGURE
B26

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 00\01 - Labadie Energy\B00 - FIGURES\DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - November PM.mxd



LEGEND

Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Utility Waste Landfill Cell LCL1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Well or Piezometer

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. LMW-6S, TP-1D AND MW-28 WERE NOT USED IN POTENTIOMETRIC SURFACE CONTOURING.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
APRIL 29, 2019 POTENTIOMETRIC SURFACE MAP

CONSULTANT
GOLDER

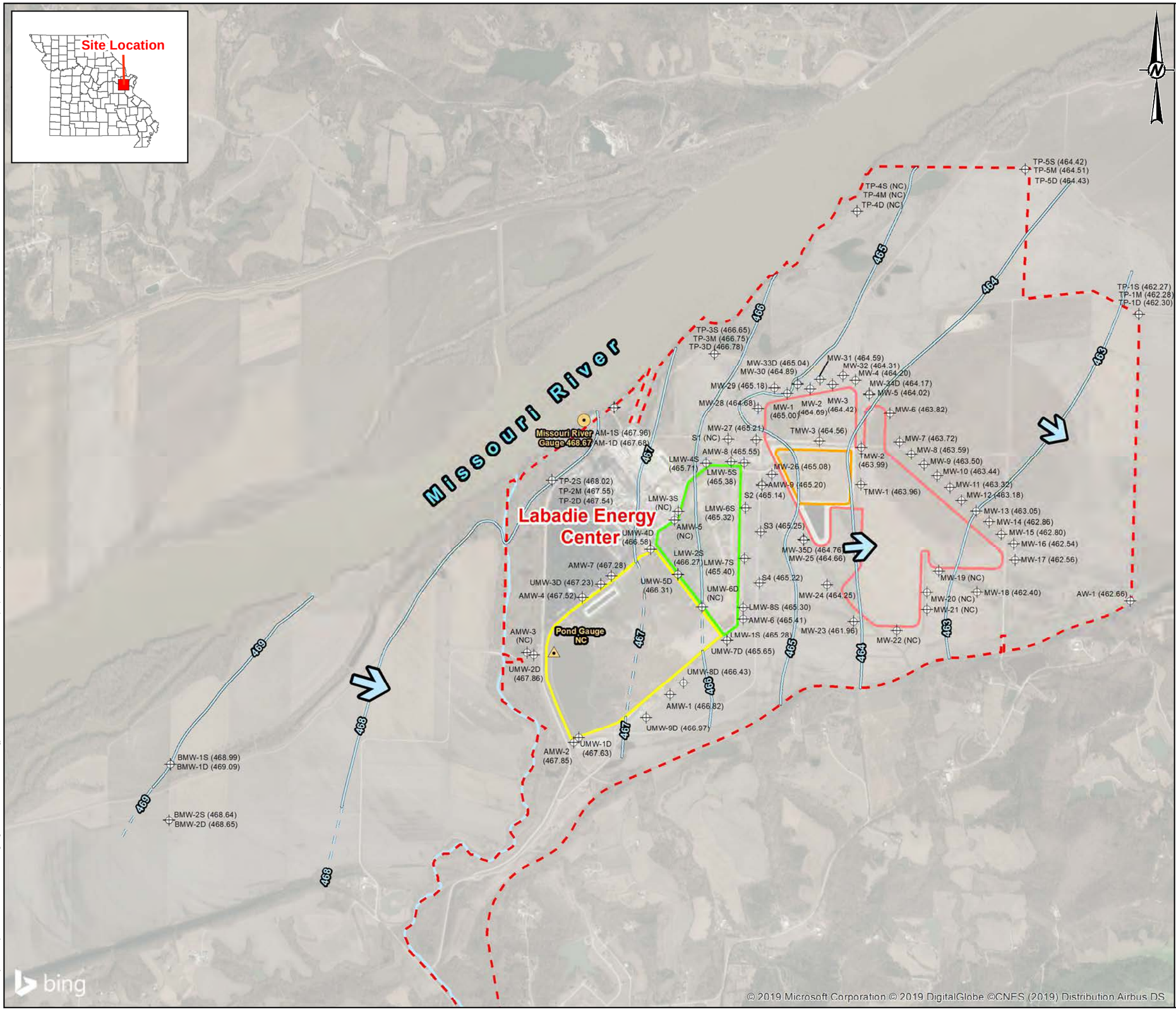
YYYY-MM-DD	2019-06-03
PREPARED	EMS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-140601
Rev. 0.0
FIGURE **B27**

AMEREN_00002731

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in x 17in

Path: G:\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map May 2019.mxd



LEGEND

- Labadie Energy Center Property Boundary

Utility Waste Landfill (UWL)

- Proposed Final UWL Fence Perimeter
- Utility Waste Landfill Cell LCL1

Surface Impoundments

- LCPA - Bottom Ash Surface Impoundment
- LCPB - Fly Ash Surface Impoundment

Groundwater Elevation Measurement Location

- Monitoring Well or Piezometer

Surface Water Elevation Measurement Location

- Missouri River Gauge
- LCPA Bottom Ash Surface Impoundment Gauge

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)
- Groundwater Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER.
3. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
4. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
5. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
6. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.
7. THE POND GAUGE WAS BELOW THE GAUGE AND THEREFORE A POND ELEVATION LEVEL WAS NOT COLLECTED (NC).
8. WATER LEVELS WERE NOT COLLECTED AT WELLS LMW-3S, MW-19, MW-20, MW-21, MW-22, TP-4S, TP-4M, TP-4D, PZ-3S/AMW-3, PZ-5D/AMW-5, AND S1.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000 6,000 Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
OCTOBER 4, 2019 POTENTIOMETRIC SURFACE MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2019-10-21
PREPARED	AMM
DESIGN	JSI
REVIEW	BCW
APPROVED	MNH

PROJECT No. 153-140601
Rev. 0.0
FIGURE **B28**

AMEREN_00002732

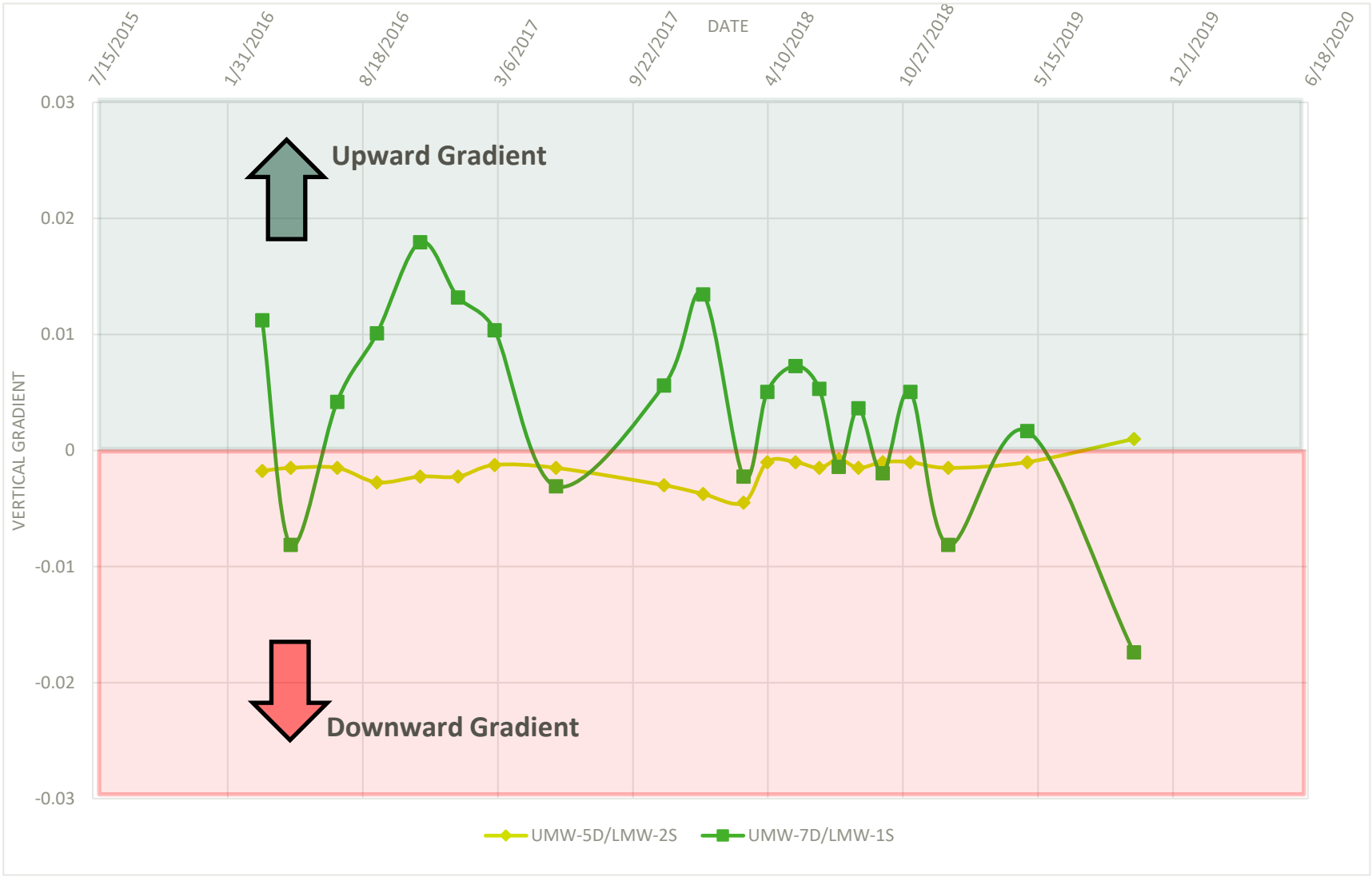
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1in 0

Path: G:\Projects\153 Projects\153-1406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\Pot Maps\Updated Pot Maps\NE pot maps\LEC - NE pot map Oct 2019.mxd

APPENDIX C

Vertical Gradients

Appendix C, Figure 1 - Vertical Gradient Analysis - Wells Adjacent to the CCR Unit

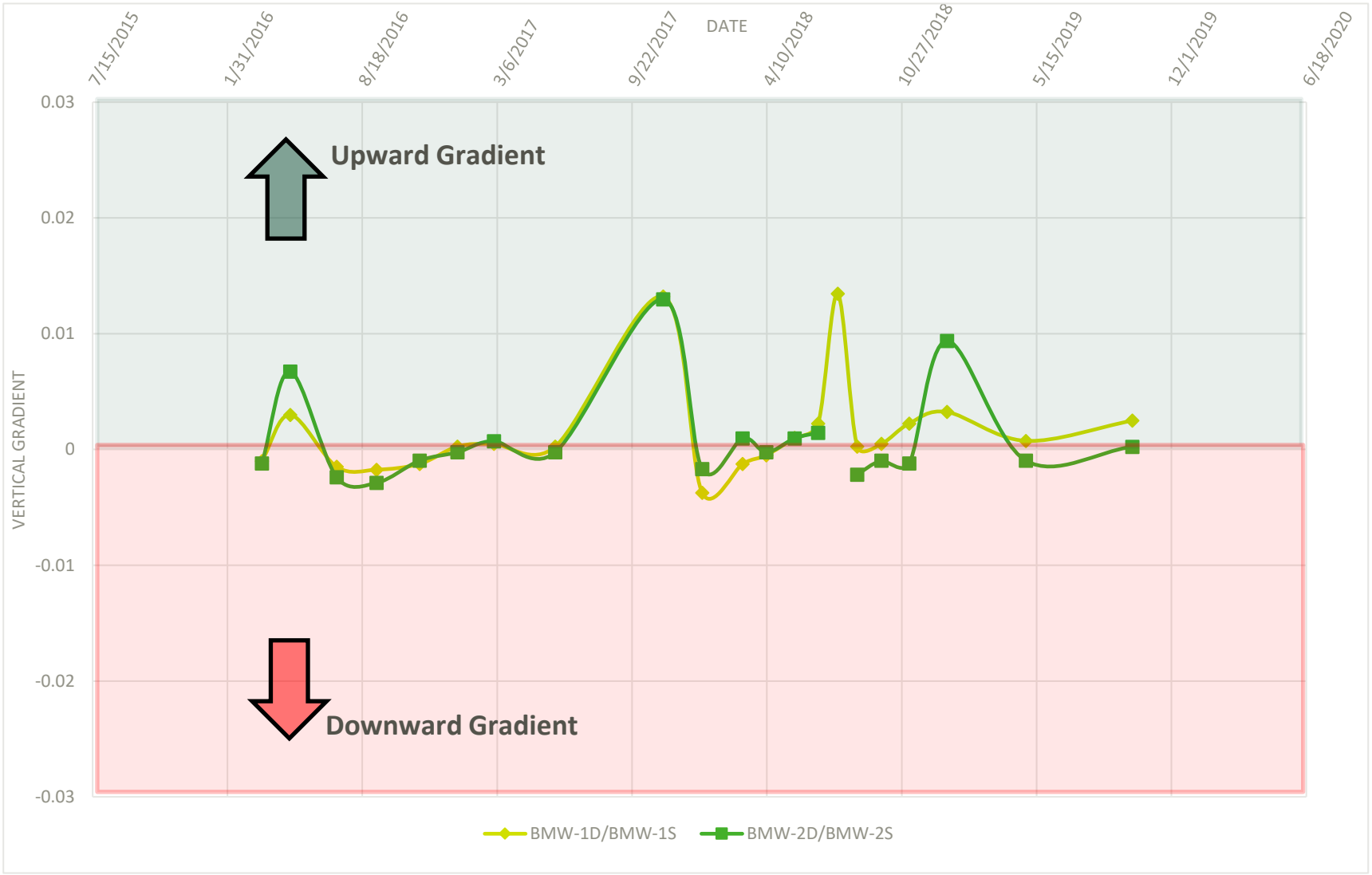


Notes:
1) A positive gradient indicates upward flow and is in the green zone.
2) A negative gradient idnicates downward flow and is in the red zone.

Prepared By: JSI 10/23/2019
Checked By: AMM 10/29/2019
Review By: MNH 11/7/2019

GOLDER

Appendix C, Figure 2 - Vertical Gradient Analysis - Background Monitoring Wells

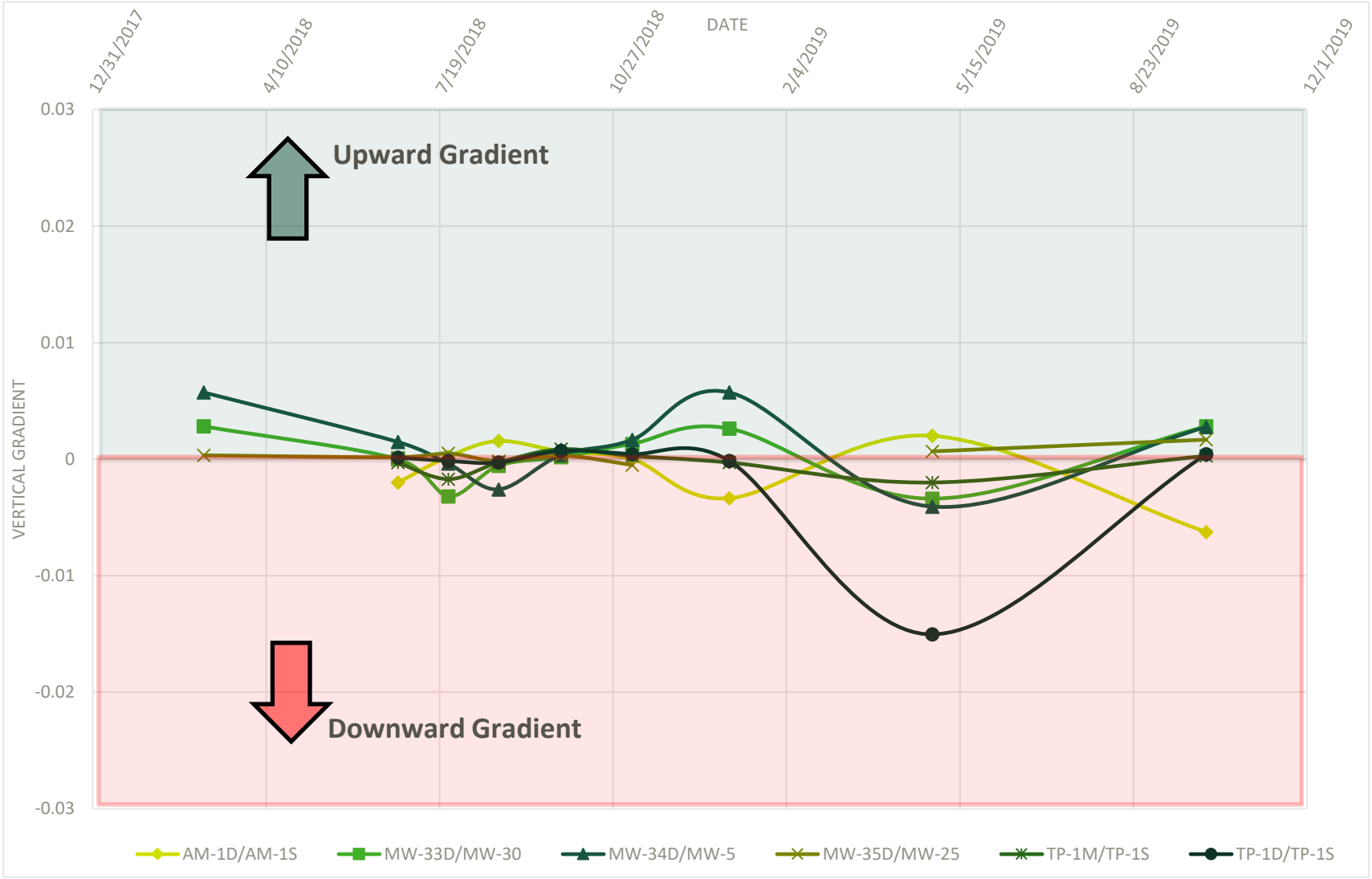


Notes:
1) A positive gradient indicates upward flow and is in the green zone.
2) A negative gradient idnicates downward flow and is in the red zone.

Prepared By: JSI 10/23/2019
Checked By: AMM 10/29/2019
Review By: MNH 11/7/2019

GOLDER

Appendix C, Figure 3 - Vertical Gradient Analysis - Additional Monitoring Well Pairs

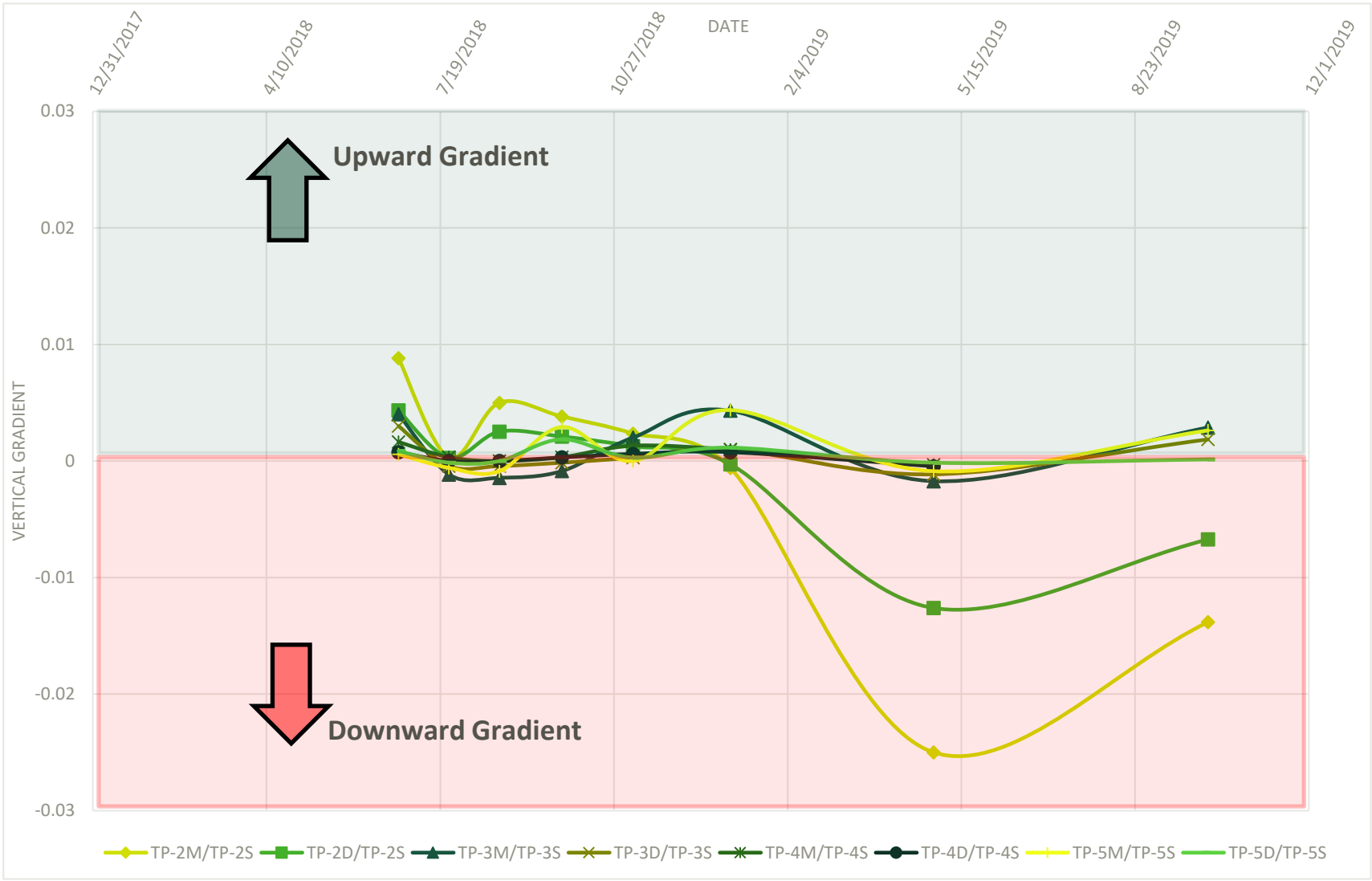


Notes:
1) A positive gradient indicates upward flow and is in the green zone.
2) A negative gradient idnicates downward flow and is in the red zone.

Prepared By: JSI 10/23/2019
Checked By: AMM 10/29/2019
Review By: MNH 11/7/2019

GOLDER

Appendix C, Figure 4 - Vertical Gradient Analysis - Additional Monitoring Well Pairs



Notes:
1) A positive gradient indicates upward flow and is in the green zone.
2) A negative gradient idnicates downward flow and is in the red zone.

Prepared By: JSI 10/23/2019
Checked By: AMM 10/29/2019
Review By: MNH 11/7/2019

APPENDIX D

Groundwater Sampling Methodology and Procedures

Groundwater Sampling Methodology and Procedures

Groundwater Monitoring Plan

Ameren Missouri
1901 Chouteau Avenue, St. Louis, Missouri 63103

Golder Associates Inc.
13515 Barrett Parkway Drive, Suite 260, Ballwin, Missouri, USA 63021

+1 314 984-8800

153140601

November 2019

Table of Contents

1.0 INTRODUCTION

Sampling will be performed in accordance with generally accepted practices within the industry and with the provisions of Missouri regulations. This document is an appendix to the Groundwater Monitoring Plan and provides details regarding the procedures that will be used to collect groundwater samples. Although this appendix provides references to specific forms, the use of other equivalent forms to record the necessary data is permissible.

2.0 GROUNDWATER SAMPLING METHODOLOGY

2.1 Monitoring Well Inspection

Prior to performing any water purging or sampling, each monitoring well will be inspected to assess its integrity. The condition of each monitoring well will be evaluated for any physical damage or other breach of integrity. The security of each monitoring well will be assessed in order to confirm that no outside source constituents have been introduced to the monitoring well.

2.2 Monitoring Well Purging

Prior to collecting samples, each monitoring well will be purged. Purging will be accomplished using either:

- Low-flow (a.k.a., minimal drawdown, or micropurge) techniques
- Traditional purging techniques where at least three well volumes are evacuated before samples are collected

2.2.1 Low-Flow Sampling Technique

Low-flow groundwater sampling procedures will be used for purging and sampling monitoring wells that are equipped with dedicated pumps/tubing and will sustain a pumping rate of at least 100 milliliters per minute (ml/min). Water will be purged from these wells at low rates in order to minimize drawdown in the well during purging and sampling. Depth to water measurements and field water quality parameters (temperature, pH, turbidity, and conductivity) recorded during purging will be used as criteria to determine when purging has been completed. Sample collection will be initiated immediately after purging at each well.

During water purging, wells will be pumped at rates that minimize drawdown in the well. Purging rates in the range of 100-500 ml/min typically will be used; however, higher rates may be used if sustained by the well. Stabilization of the water column is achieved when three consecutive water level measurements vary by 0.3-foot or less at a pumping rate of no less than 100 ml/min (United States Environmental Protection Agency [USEPA], 2010).

At a minimum, field water quality parameter measurements of temperature, pH, turbidity, and conductivity, will be measured during purging at each well. Prior to collecting the initial set of field water quality parameters, the water in the sampling pump and discharge tubing (i.e., pump system volume) remaining from the previous sampling event will be removed.

After evacuating the water in the pump system, field measurements will begin. Depth to water measurements and field water quality parameter measurements will be made during purging. If a field meter equipped with a flow cell is used, an amount of water equal to the volume of the flow cell should be allowed to pass through the flow cell between individual field stabilization measurements. Stabilization will be attained and purging considered complete when three consecutive measurements of each field parameter vary within the following limits:

- ± 0.2 for pH

- ± 3% for Conductivity
- ± 10% for Temperature
- Less than 10 nephelometric turbidity units (NTU) or ± 10% for Turbidity

All data gathered during monitoring well purging will be recorded on a form, an example of which is included in **Appendix A**.

2.3 Traditional Purge Techniques

If low-flow sampling is not performed, wells will be purged a minimum of 3 well volumes before collecting a sample. Purging procedures will generally follow those for low-flow sampling including measurement of the field parameters listed above with two exceptions:

- Higher flow rate may be used during purging
- Purging is completed after a minimum of 3 well volumes have been removed (see below)

Even where low-flow sampling is not performed, the sampling goals are to:

- Stabilize field parameters (listed in previous section) prior to collecting samples
- Minimize drawdown in the well

When traditional purge techniques are used, field stabilization measurements will be collected at the beginning of purging and between each well volume purged. The stability criteria will be those described above for low-flow sampling.

2.3.1 Low Yielding Wells

If a monitoring well purges dry, it will be allowed to recover up to 24 hours before samples are collected. No additional purging will be performed after initially purging the monitoring well dry. If recharge is insufficient to fill all necessary sample containers, samplers will note this on the field form, and fill as many sample containers as possible.

3.0 CALIBRATION, FIELD DOCUMENTATION, AND LABORATORY DOCUMENTATION

3.1 Equipment Calibration

Equipment used to record field water quality parameters will be calibrated each day prior to use following manufacturers' recommendations. Calibration solutions for standardization materials will be freshly prepared or from non-expired stock. In the absence of manufacturer or regulatory guidance, field equipment should be calibrated to within +/- 10 percent of the standard (or 0.1 standard units for pH meters). Equipment that fails calibration may not be used. Calibration records will be maintained. A sample field Instrument Calibration Form is included in **Appendix A.**

3.1.1 Sample Collection

Sampling should take place immediately after purging is complete. Samples will be transferred directly from field sampling equipment into containers supplied by the analytical laboratory appropriate for the constituents being monitored. Sample containers will be kept closed until the time each set of sample containers is filled.

3.1.2 Equipment Decontamination

All non-dedicated field equipment that is used for purging or sample collection shall be cleaned with a phosphate-free detergent and triple-rinsed, inside and out, with deionized or distilled water prior to use and between each monitoring well. Decontamination water shall be disposed of at an Ameren approved location. Any disposable tubing used with non-dedicated pumps should be discarded after use at each monitoring well. Clean latex or nitrile gloves will be worn by sampling personnel during monitoring well purging and sample collection.

3.1.3 Sample Preservation and Handling

In accordance with §257.93 of the CCR Rule, groundwater samples collected as part of the monitoring program will not be filtered prior to analysis. Once groundwater samples have been collected and preserved in laboratory supplied containers, they will be packed into insulated, ice-filled coolers to be maintained at a temperature as close as possible to 4 degrees Celsius. Groundwater samples will be collected in the designated size and type of containers required for specific parameters. Sample containers will be filled in such a manner as not to lose preservatives by spilling or overfilling. Samples will be delivered to the laboratory or sent via overnight courier following chain-of-custody procedures.

3.1.4 Chain-of-Custody Program

The chain-of-custody (COC) program will allow for tracing sample possession and handling from the time of field collection through laboratory analysis. The COC program includes sample labels, sample seals, field Groundwater Sample Collection Forms, and COC record. A sample Chain-of-Custody (COC) form is provided in **Appendix A**.

Each sample will be assigned a unique sample identification number to be recorded on the sample label. The sample identification number for all samples will be designated differently based on the nature of the samples. Each sample identification number and description will be recorded on the field Groundwater Sample Collection Form and on the COC document.

3.1.5 Sample Labels

Sample labels sufficiently durable to remain legible when wet will contain the following information, written with indelible ink:

- Site and sample identification number
- Monitoring well number or other location
- Date and time of collection
- Name of collector
- Parameters to be analyzed
- Preservative, if applicable

3.1.6 Sample Seal

The shipping container will be sealed to prevent the samples from being disturbed during transport to the laboratory.

3.1.7 Field Forms

All field information must be completely and accurately documented to become part of the final report for the groundwater monitoring event. Example field forms are included in **Appendix A**. The field forms will document the following information:

- Identification of the monitoring well
- Sample identification number
- Field meter calibration information
- Water level depth
- Purge volume
- Time monitoring well was purged
- Date and time of collection
- Parameters requested for analysis
- Preservative used
- Field water quality parameter measurements
- Field observations on sampling event
- Name of collector(s)
- Weather conditions including air temperature and precipitation

3.1.8 Chain-of-Custody Record

The COC record is required for tracing sample possession from time of collection to time of receipt at the laboratory. The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under any of the following conditions:

- It is in the individual's possession
- It is in the individual's view after being in their possession
- It was in the individual's possession and they locked it up
- It is in a designated secure area

All environmental samples will be handled under strict COC procedures beginning in the field. The field team leader will be the field sample custodian and will be responsible for ensuring that COC procedures are followed. A COC record will accompany each individual shipment. The record will contain the following information:

- Sample destination and transporter
- Sample identification numbers
- Signature of collector
- Date and time of collection
- Sample type
- Identification of monitoring well
- Number of sample containers in shipping container
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession

A copy of the completed COC form will be placed in a water-resistant bag and accompany the shipment and will be returned to the shipper after the shipping container reaches its destination. The COC record will also be used as the analysis request sheet. When shipping by courier, the courier does not sign the COC record: copies of shipping forms are retained to document custody.

3.1.9 Temperature Control and Sample Transportation

After collection, sample preservation, and labeling, sample containers will be placed in coolers containing water-ice with the goal of reducing the groundwater samples to a temperature of approximately 4°C or less. All samples included in the shipping container will be packed in such a manner to minimize the potential for container breakage. Samples will be either hand-delivered or shipped via commercial carrier to the certified analytical laboratory. Custody seals will be placed on the shipping containers if a third-party courier is used.

4.0 ANALYTICAL AND QUALITY CONTROL PROCEDURES

4.1.1 Data Quality Objectives

As part of the evaluation component of the Quality Assurance (QA) program, analytical results will be evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC). These are defined as follows:

- Precision is the agreement or reproducibility among individual measurements of the same property, usually made under the same conditions
- Accuracy is the degree of agreement of a measurement with the true or accepted value
- Representativeness is the degree to which a measurement accurately and precisely represents a characteristic of a population, parameter, or variations at a sampling point, a process condition, or an environmental condition
- Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions
- Comparability is an expression of the confidence with which one data set can be compared with another data set in regard to the same property

The accuracy, precision and representativeness of data will be functions of the sample origin, analytical procedures and the specific sample matrices. Quality Control (QC) practices for the evaluation of these data quality indicators include the use of accepted analytical procedures, adherence to hold time, and analysis of QC samples (e.g., blanks, replicates, spikes, calibration standards and reference standards).

Quantitative QA objectives for precision and accuracy, along with sensitivity (detection limits) are established in accordance with the specific analytical methodologies, historical data, laboratory method validation studies, and laboratory experience with similar samples. The Representativeness of the analytical data is a function of the procedures used to process the samples.

Completeness is a qualitative characteristic which is defined as the fraction of valid data obtained from a measurement system (e.g., sampling and analysis) compared to that which was planned. Completeness can be less than 100 percent due to poor sample recovery, sample damage, or disqualification of results which are outside of control limits due to laboratory error or matrix-specific interferences. Completeness is documented by including sufficient information in the laboratory reports to allow the data user to assess the quality of the results. The overall completeness goal for each task is difficult to determine prior to data acquisition. For this project, all reasonable attempts will be made to attain 90% completeness or better (laboratory).

Comparability is a qualitative characteristic which allows for comparison of analytical results with those obtained by other laboratories. This may be accomplished through the use of standard accepted methodologies, traceability of standards to the National Bureau of Standards (NBS) or USEPA sources, use of appropriate levels

of quality control, reporting results in consistent, standard units of measure, and participation in inter-laboratory studies designed to evaluate laboratory performance.

Data quality and the standard commercial report package will be evaluated with respect to PARCC criteria using the laboratory's QA practices, use of standard analytical methods, certifications, participation in inter-laboratory studies, temperature control, adherence to hold times, and COC documentation (also called Data Validation).

4.1.2 Quality Assurance/Quality Control Samples

This section describes the various Quality Assurance/Quality Control (QA/QC) samples that will be collected in the field and analyzed in the laboratory and the frequency at which they will be performed.

4.1.2.1 Field Equipment Rinsate Blanks

In cases where sampling equipment is not dedicated or disposable, an equipment rinsate blank will be collected. The equipment rinsate blanks are prepared in the field using laboratory-supplied analyte-free water. The water is poured over and through each type of sampling equipment following decontamination and submitted to the laboratory for analysis of target constituents. **One rinsate blank will be collected for every 10 samples.**

4.1.2.2 Field Duplicates

Field duplicates are collected by sampling the same location twice, but the field duplicate is assigned a unique sample identification number. Samplers will document which location is used for the duplicate sample. **One field duplicate will be collected for every 10 samples.**

4.1.2.3 Field Blank

Field blanks are collected in the field using laboratory-supplied analyte-free water. The water is poured directly into the supplied sample containers in the field and submitted to the laboratory for analysis of target constituents. **One field blank will be collected for every 10 samples.**

4.1.2.4 Laboratory Quality Control Samples

The laboratory will have an established QC check program using procedural (method) blanks, laboratory control spikes, matrix spikes, and duplicates. Details of the internal QC checks used by the laboratory will be found in the laboratory QAP and the published analytical methods. These QC samples will be used to determine if results may have been affected by field activities or procedures used in sample transportation or if matrix interferences are an issue. **One (1) Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) set** (i.e. one sample plus one MS, and one MSD sample at one location) **will be collected per 20 samples.** MS/MSD samples will have a naming convention as follows:

- Sample: MW-1
- MS: MW-1-MS
- MSD: MW-1-MSD

5.0 REFERENCES

MDNR. 2011. Missouri Well Construction Rules. Missouri Department of Natural Resources Division of Geology and Land Survey. Rolla, MO. August 2011.

USEPA. 2010. Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples From Monitoring Wells., U.S. Environmental Protection Agency, Revised January 19, 2010.

APPENDIX A

Example Field Forms

WELL DEVELOPMENT/PURGING FORM

Project Ref: _____ **Project No.:** _____

Location

Monitored By: _____ Date _____ Time _____

Well Piezometer Data

(*circle one)*

Depth of Well (from top of PVC or ground) _____ feet

Depth of Water (from top of PVC or ground) _____ feet

Radius of Casing _____ inches
_____ feet

Casing Volume _____ cubic feet
_____ gallons

Development / Purging Discharge Data

Purging Method _____

Start Purging Date _____ Time _____

Stop Purging Date _____ Time _____

Monitoring

Date	Time	Volume Discharge (gals)	Temp (^{o}__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments

GROUNDWATER SAMPLE COLLECTION FORM

GOLDER

Project Ref: __ _____ **Project No. :**_____

WEATHER CONDITIONS

Temperature _____ Weather _____

SAMPLE INFORMATION

Sample Location _____ Sample No. _____

Sample Date _____ Time _____ Sample By_____

Sample Method _____ Sample Type_____

Water Level Before Purging: _____

Well Volume: _____

Volume Water Removed Before Sampling: _____

Water Level Before Sampling: _____

Water Level After Sampling: _____

Appearance of Sample: _____

FIELD MEASUREMENTS

Parameter	Units	Measurement	Measurement	Measurement	Measurement	Sample
Time	hhmm					
Volume Discharge	gals					
pH	Standard					
Spec. Cond.	___S/CM					
Turbidity	NTU					
Temperature	°___					
Dissolved Oxygen	mg/l					
Redox Potential	+/- mV					

LABORATORY CONTAINERS

Sub-Sample	Analysis Requested	Type and Size of Sample Container	Filtered (Yes or No)	Type of Preservative
1				
2				
3				
4				
5				
6				
7				
8				

REMARKS: _____

NA = Not applicable

SAMPLING METHODS:

Bailer: PVC/PE
Stainless Steel
Teflon

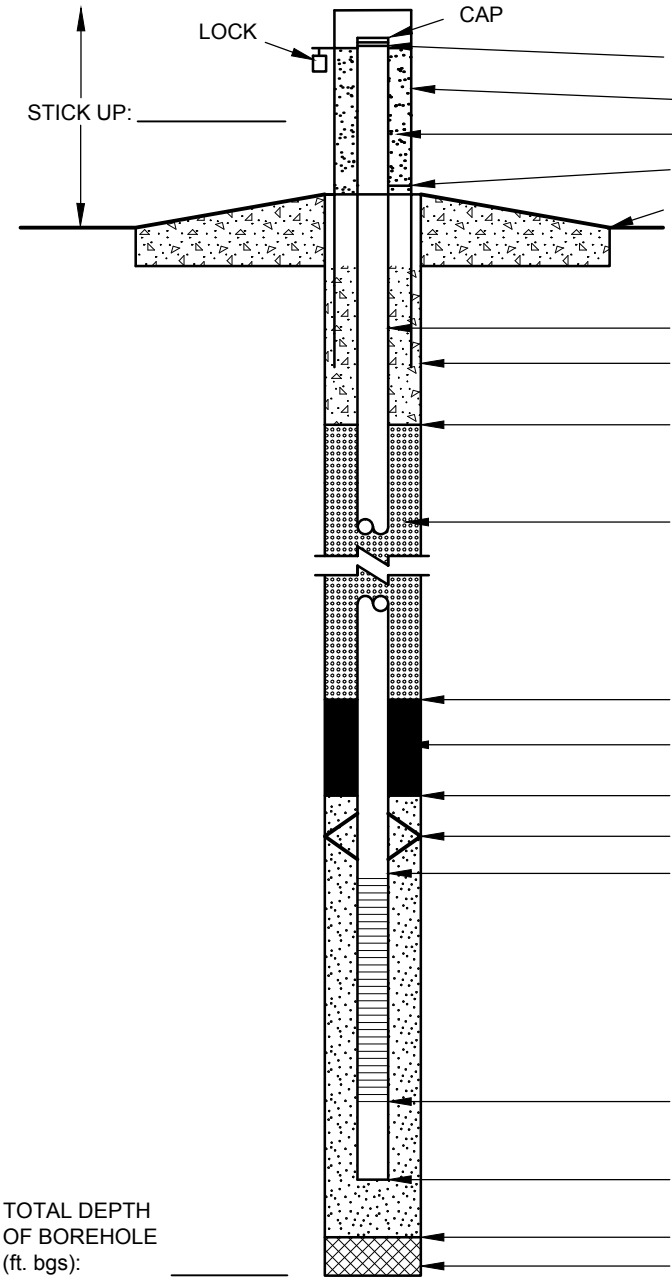
Peristaltic Pump
Submersible Pump
Hand Pump

Air-Lift Pump
Other_____

GOLDER

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG _____

PROJECT NAME:		PROJECT NUMBER:
SITE NAME:		LOCATION:
CLIENT:		SURFACE ELEVATION:
GEOLOGIST:	NORTHING:	EASTING:
DRILLER:	STATIC WATER LEVEL:	COMPLETION DATE:
DRILLING COMPANY:		DRILLING METHODS:



TOP OF CASING ELEVATION: _____

PROTECTIVE CASING (yes □no): _____

PEA GRAVEL OR SAND

WEEP HOLE

GROUND SURFACE ELEVATION: _____

DIAMETER OF RISER PIPE (in.): _____

DIAMETER OF BOREHOLE (in.): _____

CONCRETE SEAL DEPTH (ft. bgs): _____

TYPE AND AMOUNT OF ANNULAR SEAL: _____

TOP OF BENTONITE SEAL DEPTH (ft. bgs): _____

TYPE AND AMOUNT OF BENTONITE SEAL: _____

TOP OF SAND PACK DEPTH (ft. bgs): _____

CENTRALIZER (yes □no) - TYPE: _____

TOP OF SCREEN DEPTH (ft. bgs): _____

TYPE OF SCREEN: _____

SCREEN SLOT SIZE (in.): _____

SIZE OF SAND PACK: _____

AMOUNT OF SAND: _____

BOTTOM OF SCREEN DEPTH (ft. bgs): _____

BOTTOM OF WELL DEPTH (ft. bgs): _____

BOTTOM OF FILTER PACK (ft. bgs): _____

TYPE AND AMOUNT OF BACKFILL: _____

ADDITIONAL NOTES: _____

CHECKED BY: _____

DATE CHECKED: _____

PREPARED BY: _____

GOLDER

RECORD OF WATER LEVEL READINGS

Project Name: _____ **Location:** _____ **Project No.:** _____

Borehole No.	Date	Time	Measuring Device / Serial No.	Measurement Point (M.P)	Water Level Below M.P.	Correction To Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments

Sheet ___ of ___

GOLDER

INSTRUMENT CALIBRATION FORM

Project Name: _____ **Project No:** _____

Calibration By: _____

Instrument Details

Instrument Name	
Serial No.	
Model No.	

Calibration Details

Required Calibration Frequency/Last Calibration	
Calibration Standard	
Calibration Standard(s) Expiration Date	

Calibration:

Date	Time	**Calibration Standard** Units: _____	**Instrument Reading** Units: _____

Comments:

>>> Select a Laboratory <<<

#N/A
#N/A
#N/A
#N/A

Chain of Custody Record

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	_____ of _____ COCs
Address	**Analysis Turnaround Time**			Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS			**For Lab Use Only:**
(xxx) xxx-xxxx Phone	TAT if different from Below _____			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name:	☐ 1 week			
Site:	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)															Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for_____ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:	Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ Therm ID No.:_____

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Golder Associates

Field Boring Log

DEPTH HOLE _____ **PROJ. NO.** _____ **PROJECT** _____ **BORING NO.** _____

DEPTH SOIL DRILL _____ **GA INSP.** _____ **DRILLING METHOD** _____ **SHEET** _____ **OF** _____

DEPTH ROCK CORE _____ **WEATHER** _____ **DRILLING COMPANY** _____ **SURFACE ELEV.** _____

ABANDONMENT _____ **DRILL RIG** _____ **DRILLER** _____ **DATUM** _____

DEPTHS _____/_____/_____/_____ **SAMPLER HAMMER TYPE** _____ **WT.** _____ **DROP** _____ **STARTED** _____/_____
WATER LEVEL CAVE-IN DATE-TIME NOTE TIME DATE

DEPTHS _____/_____/_____/_____ **HOLE LOCATION** _____ **COMPLETED** _____/_____
(DELAYED) WATER LEVEL CAVE-IN DATE-TIME NOTE TIME DATE

SAMPLE TYPES

	A.S.	AUGER SAMPLE
	C.S.	CHUNK SAMPLE
*	D.O.	DRIVE OPEN (SPT)
	D.S.	DENISON SAMPLE
	F.S.	FOIL SAMPLE
	P.S.	PITCHER SAMPLE
	S.C.	SOIL CORE
*	T.O.	THIN-WALLED, OPEN
*	T.P.	THIN-WALLED, PISTON
	W.S.	WASH SAMPLE
*	____	_____
*	____	_____
*	____	_____

* NOTE SIZE

ABBREVIATIONS

ANG	ANGULAR	GR	GRAY	R	RED
BL	BLACK	HE	HETEROGENEOUS	RES	RESIDUAL
BR	BROWN	HO	HOMOGENEOUS	RX	ROCK
C	COARSE	LYD	LAYERED	RND	ROUNDED
CIN	CAVE-IN	M	MEDIUM	SAT	SATURATED
CO	COHESIVE	MIC	MICACEOUS	SD	SAND
CL	CLAY	MOT	MOTTLED	SI	SILT
CLY	CLAYEY	MST	MOIST	SIY	SILTY
D	DRY	NC	NON-COHESIVE	SM	SOME
EL	ELONGATED	NP	NON-PLASTIC	TR	TRACE
F	FINE	OG	ORANGE	WL	WATER LEVEL
FL	FLAT	ORG	ORGANIC	WH	WEIGHT OF HAMMER
FRAG	FRAGMENTS	PP	POCKET PEN.	WR	WEIGHT OF RODS
GL	GRAVEL	PL	PLASTIC LIMIT	Y	YELLOW

ORDER OF DESCRIPTION

CONSTITUENTS
1) GROUP SYMBOL
2) SOIL GROUP NAME
3) PRIMARY COMPONENTS
4) SECONDARY COMPONENTS
5) MINOR COMPONENTS;

PLUS DESCRIPTION:
CL/SI: PLASTICITY
SD: SIZE, GRADING
GL: SIZE, GRADING, SHAPE, ROCK TYPE

GENERAL
6) COLOR
7) WEATHERING
8) STRUCTURE
9) SENSITIVITY
10) CONTAMINATION
11) MINEROLOGY
12) ORIGIN;

BEHAVIOR
13) BEHAVIOR (CO/NC)
14) MOISTURE/WATER CONTENT
15) DENSITY/CONSISTENCY

PROPORTIONS

"TRACE"	0 – 5%
"SOME"	5 – 12%
PREFIX "-Y"	12 – 35%
"AND"	35 – 50%

NON-COHESIVE SOILS

RELATIVE DENSITY		BLOWS
VERY LOOSE	VLS	0 – 4
LOOSE	LS	4 – 10
COMPACT	CP	10 – 30
DENSE	DN	30 – 50
VERY DENSE	VDN	>50

MOISTURE CONDITION

DRY	SOIL FLOWS
MOIST	FEELS COOL
WET	WITH FREE WATER

COHESIVE SOILS

CONSISTENCY		PP(TSF)	FINGER PRESSURE
VERY SOFT	VS	<0.25	EXTRUDES
SOFT	S	0.25 - 0.5	MOLDS EASILY
FIRM	FM	0.5 – 1	MOLDS
STIFF	ST	1 – 2	THUMB INDENTS
VERY STIFF	VST	2 – 4	THUMBNAIL INDENTS
HARD	H	>4	RESISTS THUMBNAIL

WATER CONTENT - W

W < PL	CANNOT ROLL 4 mm THREAD
W ~ PL	CAN ROLL THREAD 2 – 4 mm
W > PL	CAN ROLL THREAD <2 mm

ELEV. / DEPTH	LITHOLOGY	SAMPLES NO.	TYPE	DEPTH	SPT N / PP(TSF)	BLOWS PER 6 IN	REC / ATT	CONSTITUENTS GL	SD	CL/SI (PROPORTION; SIZE, SHAPE, GRADING; PLASTICITY)	BEHAVIOR CO or NC	MOIST. or W	DENS./ CONS.	USCS	SAMPLE DESCRIPTION AND DRILLING NOTES

GOLDER

APPENDIX E

Statistical Analysis Plan

Corrective Action Statistical Analysis Plan

Labadie Energy Center - Franklin County, Missouri

Submitted to:

Ameren Missouri

1901 Chouteau Avenue, St. Louis, Missouri 63103

Submitted by:

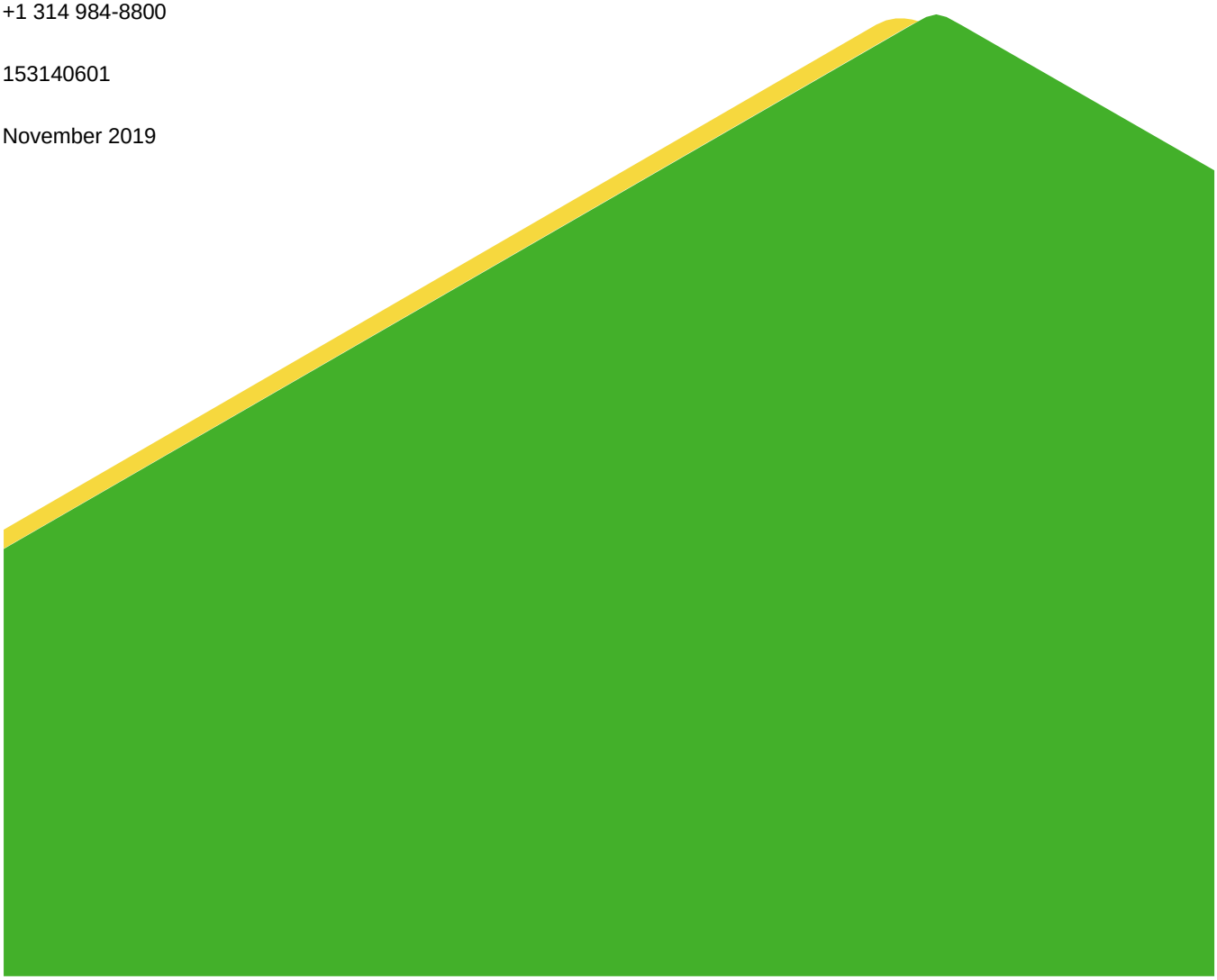
Golder Associates Inc.

13515 Barrett Parkway Drive, Suite 260, Ballwin, Missouri, USA 63021

+1 314 984-8800

153140601

November 2019



Executive Summary

This Corrective Action Statistical Analysis Plan (SAP) was developed to meet the requirements of United States Environmental Protection Agency (USEPA) 40 CFR Part 257 “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule” (the Rule or CCR Rule), specifically § 257.98(a)(1) on the Implementation of a Corrective Action Program. This section of the CCR Rule requires owners or operators establish and implement a Corrective Action Groundwater Monitoring Plan (GMP) within 90 days of selecting a remedy. On August 30, 2019 Ameren Missouri (Ameren) selected the remedy of source control through installation of a low permeability cover system and use of Monitored Natural Attenuation (MNA) for groundwater impacts from the LCPA Surface Impoundment at the Labadie Energy Center (LEC).

As a part of the groundwater sampling and analysis requirements of the Rule, statistical methods as described in Section §257.93(f) of the Rule need to be implemented to statistically evaluate groundwater quality. The selected statistical method must then be certified by a qualified Professional Engineer stating that the statistical method is appropriate for evaluating the groundwater monitoring data for the CCR Unit. Detailed descriptions of the acceptable statistical data methods are provided in the USEPA’s “Statistical Analysis of Groundwater Data at RCRA Facilities, Unified Guidance” (USEPA, 2009) (Unified Guidance). The Unified Guidance is also recommended in the CCR Rule to be used for guidance in the selection of the appropriate statistical evaluation method.

This SAP details the statistical procedures to be used for Corrective Action monitoring for Ameren Missouri at the above mentioned CCR Unit. Details on statistical analysis for detection monitoring and assessment monitoring are provided in the GMP for the LCPA and are not included in this document. Detailed information on collection, sampling techniques, preservation, etc. are provided in the Corrective Action Groundwater Monitoring Plan (GMP) for the CCR Unit specified above. This SAP is a companion document to the GMP and assumes that data analyzed by the procedures described in this SAP are from samples that were collected in accordance with the Corrective Action GMP.

This SAP was prepared by Golder Associates Inc. (Golder), on behalf of Ameren, to document appropriate methods of groundwater data evaluation in compliance with CCR Rules. The methods and groundwater data evaluation techniques used in this SAP are appropriate for evaluation of the groundwater monitoring data for the above mentioned CCR Unit and are in compliance with performance standards outlined in the CCR Rule.

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1.0 INTRODUCTION

This SAP discusses the procedures, methods, and processes that will be implemented as part of the Corrective Action statistical evaluation. Corrective Action statistical analysis will begin once source control through the installation of a low permeability cover system is complete. Additionally, as specified in the Corrective Action GMP, a minimum of eight rounds of sampling for all constituents present at a Statistically Significant Level (SSL) from Assessment Monitoring will be collected prior to initiating statistical analysis. This background monitoring period provides baseline data for each monitoring well which can be used as the basis of the statistical evaluation.

2.0 STATISTICAL DATA PREPARATION AND INITIAL REVIEW

Many of the statistical comparison tests used in Corrective Action monitoring require various analyses to be completed prior to the data being used for the calculation of statistical limits. This section discusses the methods and procedures for completing the initial review of the data. The analyses required include testing for statistical independence, physical independence, and procedures to evaluate potential outliers.

2.1.1 Physical and Statistical Independence of Groundwater Samples

Corrective Action Monitoring statistical evaluations assume that background and downgradient sampling results are statistically independent. The Unified Guidance states that *"Physical independence of samples does not guarantee statistical independence, but it increases the likelihood of statistical independence."* (Section 14.1, Unified Guidance). Physical independence is most likely achieved when consecutive groundwater samples are collected from independent volumes of water within a given aquifer zone. Using the Darcy Equation, minimum time intervals between sampling events can be calculated to confirm the minimum time interval for groundwater to travel through the borehole is less than the time between sampling events (**Table 1, Physical Independence**). This minimum time can be calculated as displayed in Section *14.3.2* of the Unified Guidance. This table displays the range of conductivities collected onsite. If a sampling frequency less than those provided below are to be used, then well specific calculations will need to be completed to ensure that the samples will be physically independent.

Table 1: Physical Independence

Well ID	Hydraulic Conductivity	Average Hydraulic Gradient	Effective Porosity	Well Bore Volume	Minimum Time
Symbol	K	I	n	D	T_{min}
Units	Feet/Day	Feet/Foot	%	Feet	Days
Detailed Site Investigation (DSI)					
Minimum	29	0.0004	0.35	0.5	15.6
Average	71	0.0004	0.35	0.5	6.3
Maximum	136	0.0004	0.35	0.5	3.3
CCR Rule Monitoring Wells					
Minimum	31	0.0004	0.35	0.5	14.4
Geomean	60	0.0004	0.35	0.5	7.5
Maximum	128	0.0004	0.35	0.5	3.5

Notes:

1. Average hydraulic gradient and effective porosity obtained from GMP
2. Hydraulic conductivity obtained from ranges provided in GMP
3. Calculation completed using the Darcy Equation as outlined in section 14.3.2 of the Unified Guidance.

2.1.2 Data Review – Testing for Outliers

Careful review of the data is critical for verifying that there is an accurate representation of the groundwater conditions. Early identification of anomalous data (outliers) helps play a key role in a successful SAP. Possible causes for outliers include:

- Sampling error or field contamination;
- Analytical errors or laboratory contamination;
- Recording or transcription errors;
- Faulty sample preparation, preservation, or shelf-life exceedance; or
- Extreme, but accurately detected environmental conditions (e.g., spills, migration from the facility).

The following sections outline a few graphical and statistical tests that should be completed prior to using the data to calculate statistical limits.

2.1.2.1 Time Series Plots

Time Series plots are a quick and simple method to check for possible outliers. Time series plots should be generated with the concentration of the analyte on the Y-axis and the sample date (time) on the X-axis. If any data points look to be potential outliers, the data should be flagged and further evaluated as described in Section 2.1.2.2 below.

2.1.2.2 Dixon's and Rosner's Tests

If graphical methods demonstrate that potential outliers exist, further investigation of these data points can be completed using Dixon's test for datasets with fewer than 25 samples and Rosner's test with datasets greater than 20 samples. Formal testing should only be performed if an observation seems particularly high compared to the rest of the dataset. If statistical testing is to be completed to whether an outlier exists, it should be cautioned that these outlier tests assume that the rest of the data (other than the outlier) are normally distributed. Additionally, because log-normally distributed data often contain one or more values that appear high relative to the rest, it is recommended that the outlier test be run on the transformed values instead of their original observations. This way, one can avoid classifying a high log-normal measurement as an outlier just because the test assumptions were violated. Most groundwater statistical packages can complete Dixon's and Rosner's tests and more information about Dixon's and Rosner's tests is provided in Sections 12.3 and 12.4 of the Unified Guidance. If the test designates an observation as a statistical outlier, the source of the abnormal measurement should be investigated. In general, if a data point is found to be a statistical outlier, it should not be used for statistical evaluation. However, outlier removal should be performed carefully, and typically only when a specific cause for the outlier can be identified.

In some cases where a specific cause for an outlier cannot be identified, professional judgment can be used to determine whether the outlier significantly affects the statistical results to the extent that removal is deemed necessary. If an outlier value with much higher concentration than other background observations is not removed from background prior to statistical testing, it will tend to increase both the background sample mean and standard deviation. In turn, this may substantially raise the magnitude of the prediction limit or control limit calculated from that data set. Thus, experience shows that it is a good practice to remove obvious outliers from the database even when independent evidence of the source of the outlier does not exist. The removal of outliers tends to

normalize the data and therefore produce a more robust statistical limit. Outlier removal also tends to produce a more conservative statistical limit, since the data variability is decreased, thereby decreasing the standard deviation.

2.1.3 Calculate for Mean and Standard Deviation

Following outlier removal, initial summary statistics including mean and standard deviation should be calculated for the background monitoring well datasets. While these summary statistics are easily completed in many groundwater statistical software packages, it is important to account for values that have low or zero values as described below.

2.1.3.1 Reporting of Low and Zero Values

2.1.3.1.1 Estimated Values (J Flag)

Estimated values are values that have a concentration between the method detection limit (MDL[1]) and the practical quantitation limit (PQL[2]) for any given compound. These values are typically displayed with a J flag in laboratory report packages and are often referred to as "J-values". In most cases, The Unified Guidance recommends using the estimated value provided for statistical evaluation. Estimated values are typically used because the accuracy and power of most statistical evaluations lose power as the percentage of non-detects (NDs) increases. While they are below the PQL, estimated values are considered detectable concentrations for statistical calculations, which has the effect of lowering the percentage of NDs.

This "rule" should be applied with care, as there is an exception. Estimated values are not considered detectable concentrations if all values for a single constituent are less than the PQL. In these cases, the Double Quantification Rule (DQR) as described in this CCR Units GMP should be used.

2.1.3.1.2 Non-Detects Values (ND)

Non-Detect Values (ND) are concentrations that were not detected at a concentration above the MDL. ND values are typically displayed with a "U" or "ND" flag in laboratory data report packages. The following approaches for managing ND values are based on recommendations in the Unified Guidance and are applicable for use with the statistical evaluation procedures that will be further discussed and used in this SAP (prediction intervals, confidence intervals, and tolerance intervals):

- If <15% ND below the PQL, substitute ½ the PQL;
- If between 15% to 50% ND below the PQL, use the Kaplan-Meier or robust regression on ordered statistics to estimate the mean and standard deviation;
- If >50% but less than 100% ND below the PQL, use a non-parametric test; or
- If 100% of values are less than the PQL, use the Double Quantification Rule (If necessary)

[1] MDL = lowest level of an analyte (substance) that the laboratory can reliably detect with calibrated instrumentation; generally based on results of an annual "MDL study" performed in accordance with 40 CFR Part 136, Appendix B; MDLs are generally set using laboratory grade deionized water spiked with a known concentration and thus do not account for effects of matrix interference inherent in typical groundwaters.
[2] PQL = minimum concentration of an analyte (substance) that can be measured with a high degree of confidence that the analyte is present at or above that concentration (typically 5-10x higher than the MDL).

2.1.4 Data Distribution

Statistical evaluations of groundwater data require an understanding of the data distribution for each analyte in each monitoring well. Data typically fall into one of the following distributions:

- **Normal distribution** – Sometimes referred to as Gaussian distribution, a normal distribution is a common continuous distribution where data form a symmetrical bell-shaped curve around a mean. Normally distributed data are tested using parametric methods.
- **Transformed-normal distribution** – Similar to a normal distribution, however, data are asymmetrical until transformation is applied to all data which then causes it to form a bell-curve. Transformed-normal data distributions are also tested use parametric methods.
- **Non-Normal Distribution** – When the data are not or cannot be transformed into a symmetrical distribution. Non-normal data distributions are tested using Non-parametric methods.

Testing for data distributions can be completed in several different ways including the skewness coefficient, probability plots with Filliben's test, or the Shapiro-Wilk/Shapiro-Francia Test. All of these methods may be employed, however, the Shapiro-Wilk and Shapiro-Francia tests are generally considered the best method according to the Unified Guidance. The Shapiro-Wilk test is best for sample sizes under 50 while the Shapiro-Francia test is best with larger datasets of 50 or more observations. Most groundwater statistical software packages can complete both Shapiro-Wilk and Shapiro-Francia tests and a detailed discussion of the testing procedures is provided in Section *10.5.1* of the Unified Guidance.

Based on the outcome of the data distribution testing, data will use either Parametric or Non-parametric tests. It is important to note that non-parametric testing usually requires larger datasets in order to minimize the Site Wide False Positive Rate (SWFPR) therefore when the raw data are not normally distributed, a transformed-normal distribution is preferred when possible.

2.1.5 Temporal Trend

Most statistical tests assume that the sample data are statistically independent and identically distributed. Therefore, samples collected over a period of time should not exhibit a time dependence. A time dependence could include the presence of trends or cyclical patterns when observations are graphed on a time series plot. Trend analysis methodologies test to see whether the dataset displays an increasing, decreasing, or seasonal trend.

If a trend is suspected, a Theil-Sen trend line should be used to estimate slope and the Mann-Kendall Trend Test should be used to evaluate the slope significance (Chapter 14, Unified Guidance). Following implementation of a successful remediation strategy, it is expected that CCR-related groundwater constituents concentrations will decrease with time. If a statistically significant trend is reported, based on a Sen's slope/Mann-Kendall trend test, it is inappropriate to perform "normal" statistical calculations (see Section 21.3 of the Unified Guidance). In such cases, an adjustment or an alternate method is required.

3.0 CORRECTIVE ACTION STATISTICAL EVALUATION

Following the removal of outliers and the performance of general statistics described in Section 2.0, the specific Corrective Action Statistical Evaluation will be completed. This evaluation is very similar to the Assessment Monitoring statistical procedures except the null hypothesis for the confidence intervals is reversed. For Corrective Action, the Unified Guidance states that the appropriate null hypothesis is that the groundwater

population (mean) exceeds the GWPS for those constituents that exceed the GWPS under Assessment Monitoring program. Therefore, in Corrective Action the Upper Confidence Limit (UCL) is compared to the Groundwater Protection Standard (GWPS) instead of the Lower Confidence Limit (LCL) [as was used during Assessment Monitoring].

3.1 Statistical Power

One of the primary goals of the selection of a proper statistical evaluation method is to limit the potential for results to falsely trigger a compliance while also maintaining sufficient statistical power to detect when compliance is achieved. Falsely triggering compliance when groundwater concentrations are still statistically above the GWPS occurred is referred to as a false positive in corrective action. The False Positive Rate (FPR), typically denoted by the Greek letter α, is also known as the "significance level". The FPR is the probability that a future compliance observation will be declared to be from a different statistical distribution than the background data. If the FPR is set too high, it can lead to the conclusion that there is evidence of impact when none exists. Conversely, if the FPR is set too low, it can lead to a false conclusion that no contamination exists, when it actually does exist (also known as a "false negative"). Ultimately, the ability to accurately identify compliance depends on the selection of an appropriate FPR, which is referred to as the statistical power. However, statistical analysis programs and the resulting decision making do not depend on each individual measurement/comparison error rates but are dependent on the collective error rate from all of the individual comparisons.

In Corrective Action monitoring, it is not possible to calculate a FPR or a site-wide false positive rate, as is calculated during Detection Monitoring. The Unified Guidance gives two methods for determining the statistical power in Corrective Action monitoring, both methods are dependent on the minimizing the FPR and at the same time minimizing the false negative rate. As stated in the Unified Guidance, ultimately, the statistical power of the confidence interval test will increase as the sample size increases, as long as the FPR is held constant. For this CCR Unit, an initial FPR of 0.05 is proposed for the confidence interval test methodology. Initially, when sample sizes are low, the overall power of the test will also be relatively low, but the power (and thus the confidence in making sound judgements relative to the success of the remedial efforts) will increase over time, as the sample size increases.

Ultimately, the goal of Corrective Action monitoring is to determine whether the selected remedy has been effective in cleaning up the groundwater to a point at which continued monitoring is no longer required. In that sense, the power of the statistical approach is important for confirming that the statistical method is accurately determining the end point of the remedial effort. Thus, particular caution will be exercised in situations where the compliance statistic (in this case, the upper confidence level (UCL), is at or near the compliance limit (in this case, the groundwater protection standard [GWPS]). Corrective Action monitoring will only be discontinued if it can be clearly demonstrated that the UCL is and will remain below the GWPS. Additional discussion is provided below regarding the specifics of the confidence interval method that will be used in Corrective Action monitoring.

3.2 Confidence Interval Approach

The statistical method for evaluating data in Correction Action is similar to the method that was used during Assessment Monitoring. Thus, intrawell confidence intervals will be calculated for each detected Appendix IV constituent in each well and the resulting confidence intervals will be compared with the appropriate Groundwater Protection Standard (GWPS). During the Assessment Monitoring phase of the program, a site wide GWPS

generated for each detected Appendix IV constituent. Over time, as additional background data are collected, the GWPS will be updated accordingly, as described in Section 3.2.2, below.

3.2.1 Maximum Contaminant Level (MCL) Based GWPS

All the Appendix IV analytes have either an USEPA MCL or a health based GWPS that was adopted for Appendix IV parameters without an MCL (i.e. cobalt, lithium, molybdenum, and lead). As specified in Section §257.95(b) of the CCR Rule, the GWPS must either be the MCL (or adopted heath based standard), or a limit based on site-specific background data, whichever is greater. This section describes the methods to be used for statistical analysis when the MCL (or adopted heath based standard) is to be used as the GWPS. Additional discussion is provided below in Section 3.2.2 for situations where the site-specific background is greater than the MCL or health based standard.

For Corrective Action, the Unified Guidance recommends the confidence interval method to evaluate for potential compliance under the GWPS (Chapter 22, Unified Guidance). Using confidence intervals, potential compliance under the GWPS is identified by comparing the calculated confidence interval against the GWPS. A confidence interval statistically defines the upper and lower bounds of a specified population within a stipulated level of significance. Confidence intervals are required to be calculated based on a minimum of 4 independent observations, but a more representative confidence interval can be developed when all of the available data are used. As discussed in Section 3.1, above, the statistical power of the method increases with an increasing number of observations, so it is generally preferred that all available data be used to calculate the confidence interval. However, if trends are noted in the data, it may be necessary to exclude historical data prior to the trend, so that the confidence interval can be more accurately calculated. As described in preceding sections, it is expected that trends will develop following the implementation of remedial actions, and thus, it is likely that the well specific data sets will require adjustment over time to account for trends.

The specific type of confidence interval should be based the attributes of the data being analyzed, including: (1) the data distribution, (2) the detection frequency, and (3) potential trends in the data. **Table 2** below is based on Table 4-5 from the Electric Power Research Institute's *Groundwater Monitoring Guidance for the Coal Combustion Residual Rule* (2015), which displays the criteria for selecting an appropriate confidence interval. The method and procedure for calculating the UCL and LCL is provided in the section reference from the Unified Guidance, which is listed in the last column of **Table 2**, below.

Table 2: Confidence Interval Method Selection

Data Distribution	Non-detect Frequency	Data Trend	Confidence Interval Method
Normal	Low	Stable	Confidence Interval Around Normal Mean (Section 21.1.1)
Transformed Normal (Log-Normal)	Low	Stable	Confidence Interval Around Lognormal Arithmetic Mean (Section 21.1.3)
Non-normal	N/A	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Cannot Be Determined	High	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Statistical Trend Noted in Well Specific Data Set	Low	Trend	Confidence Band Around Theil-Sen Line (Section 21.3.2)

In a Corrective Action monitoring program, the UCL is of primary interest. If the UCL exceeds the GWPS, the constituent is still present at a concentration that is statistically above the GWPS; however, if the UCL is less than the GWPS, the constituent is below the GWPS. If the UCL is lower than the GWPS for three consecutive years, then the monitoring well is in considered to be in full compliance.

As discussed above in Section 3.1, during Corrective Action, a per test FPR (α) of 0.05 will be used as an initial error level for calculating the two-tailed confidence intervals for the compliance wells (which actually means 2.5% FPR per tail). In some cases, based on recommendations from the Unified Guidance, it is appropriate to adjust the FPR of the confidence interval based on the number of data points available as well as the distribution of the data being evaluated. If deemed necessary based on recommendations from the Unified Guidance, an approach is provided in Section 22 of the Unified Guidance for determining an appropriate per test FPR based on the data characteristics.

When performing Corrective Action monitoring statistical evaluations, it is important to evaluate the compliance data for shifts. If no shifts have occurred, then all of the available Appendix IV data for a particular constituent can be used in the statistical evaluation. If shifts are noted (typically based on qualitative evaluation of a time series plot), only the data collected after the shift should be used in the statistical evaluation.

3.2.2 Updating the GWPS

In general, the GWPS have already been established for each Appendix IV constituent at this CCR Unit. However, it may be necessary to update the GWPS in the future to account for changes in background constituent concentrations. Recalculating the GWPS by incorporating additional background data over time typically results in a more robust value for the GWPS. During Corrective Action monitoring, background or historical concentration limits should be assessed using the following techniques for each of the detected

Appendix IV analytes. These concentration limits should then be compared with the MCL or health-based value, and the higher of these two values will be used as the GWPS. Updates to the GWPS will only apply to those constituents whose site-specific background concentration is above the established MCL or health-based value. Additional details regarding the timeframes for updating the GWPS are provided in Section 3.4, below.

The Unified Guidance provides two acceptable approaches for establishing a non-MCL based GWPS. As described in the SAP of the this CCR Units GMP, for situations where the site-specific background is greater than the MCL/health base limit, the two methods for calculating the GWPS include the tolerance interval approach or the prediction interval approach, described further below.

3.2.2.1 Tolerance Interval Approach

If the background dataset is normally or transformed normally distributed, the Unified Guidance recommends Tolerance Intervals over the Prediction Intervals for establishing a GWPS. The GWPS should be based on a 95 percent coverage/95 percent confidence tolerance interval. If the background data are non-normal (even after transformation), then a large number of background observations are required to calculate a non-parametric tolerance interval (typically a minimum of 60 background observations are required to meet these requirements). If there is an insufficient number of background observations to calculate a non-parametric tolerance interval, then a non-parametric Prediction Interval approach should be used, as described in Section 3.2.2.2 below.

The Upper Tolerance Limit (UTL) is calculated for each required Appendix VI constituent. Tolerance Limits, as outlined in the Unified Guidance (Section 17.2), are a concentration limit that is designed to contain a pre-specified percentage of the dataset population. Two coefficients associated with tolerance intervals are (1) the specified population proportion and (2) the statistical confidence. The coverage coefficient (γ), which is used to contain the population portion, and the tolerance coefficient (or confidence level (1-α)), which is used to set the confidence of the test. Typically, the UTL is calculated to have both a coverage and a confidence of 95%. When the background concentrations are greater than the MCL, the calculated UTL for each constituent is used as the GWPS. The intrawell confidence interval for each required Appendix IV constituent is then compared with the GWPS.

In order to calculate a valid confidence interval, a minimum of four data points are necessary for each of the required Appendix IV constituents in each compliance monitoring well; however a dataset of at least eight samples is recommended by the Unified Guidance. Using the Tolerance Interval Approach, a monitoring well is considered “in compliance” when the calculated UCL for each parameter in that well is less than the GWPS for three consecutive years.

Tolerance Intervals can be completed using both parametric (Section 17.2.1 of Unified Guidance) or non-parametric methods (Section 17.2.2 of Unified Guidance). However, as described above, the non-parametric method requires at least 60 background (or historical) measurements in order to achieve 95% confidence with 95% coverage. Tolerance Intervals can be calculated using most groundwater statistical software packages.

3.2.2.2 Prediction Interval Approach

If Tolerance Intervals cannot be used to calculate the GWPS (based on recommendation from the Unified Guidance, such as non-parametric datasets, etc.), then a Prediction Interval method should be used. This method is very similar to the methods used for Detection Monitoring as specified in the SAP of the GMP for this CCR Unit; however, for Corrective Action, the Unified Guidance suggests using a prediction interval about a future

mean for normally/transformed-normally distributed datasets or a prediction interval about a future median for datasets with a high percent of ND or non-normally distributed data.

When using prediction intervals to calculate for a GWPS, a one-sided prediction interval is calculated using background (or historical) datasets based on a specified number of future comparisons - four future comparisons is typical. The Upper Prediction Limit that is calculated as a product of this method then becomes the GWPS and is compared against the confidence interval for the compliance data, as described in Section 3.2.2.1 above. As also described above, if the UCL is less than the calculated prediction limit for each constituent for three consecutive years then the monitoring well is “in compliance”.

3.3 Completing Corrective Action Monitoring

As specified in 257.98(C) of the CCR Rule, because the selected remedy (capping and closure) depends on a monitored natural attenuation approach, in order to complete corrective action monitoring and declare the remedial efforts completed the following must be demonstrated:

- Compliance with the GWPS at all points within the plume of contamination that lie beyond the Detection/Assessment Groundwater Monitoring Well Network.
- Compliance with the GWPS where concentrations of constituents listed in Appendix IV have not exceeded the GWPS for a period of three consecutive years.

Additionally, because Corrective Action can be a dynamic process, with frequent changes in plume concentrations and size, individual monitoring wells may be removed from corrective action once they are under the GWPS for three consecutive years. The Corrective Action Program, however, will only be deemed competed once all points within the plume beyond the detection/assessment monitoring groundwater monitoring well system are statistically within compliance of the GWPS.

3.4 Updating Background Values

The Unified Guidance suggests that updating statistical limits should only be completed after a minimum of 4 to 8 new measurements are available (i.e., every 2 to 4 years of semiannual monitoring). The periodic update of background, during which additional data are incorporated into the background, improves statistical power and accuracy by providing a more conservative estimate of the true background population. Prior to incorporating new data into the background dataset, a test should be performed to demonstrate that the “new data” are from the same statistical population as the existing background results. Below are three methods that can be used in determining whether the “new” data should be included in the background:

- Time Series Graphs – As described in Section 2.1.2.1, time series graphs can be used as a qualitative test to assist with the determination whether a new group of data match the historical data or if there is a concentration trend that could be indicative of a release or evolving groundwater conditions.
- Box-Whisker plots can also be used to determine whether or not the datasets are similar.
- Mann-Whitney (or Wilcoxon Rank) Test – Used to evaluate the ranked medians of both the historical and new dataset populations. An α of 0.05 should be used for this evaluation. After calculation, if the Mann-Whitney statistic does not exceed the critical point, the test assumes that the two data populations have equal medians, and therefore are likely similar.

Ultimately, the Mann-Whitney (Wilcoxon Rank Sum) Test is the statistical test that will be used to determine whether new observations should be included in the background dataset. It is important to note that a difference in background datasets does not automatically prevent the new data from being used; however, if differences are noted, a review of the new data will be conducted to determine if the noted difference is a result of a change in the natural conditions of the groundwater or if it is the result of a potential release from the CCR Unit. If the new data are included in the background dataset, the GWPS will be recalculated, as described above.

3.5 Alternative Source Demonstrations

If the Corrective Action statistical evaluation for detected Appendix IV parameters determines that a constituent has a UCL above the GWPS that was not identified as an SSL in Assessment Monitoring, then the data must be evaluated to determine if the cause of elevated UCL is due to a release from the CCR Unit or from an alternative source. Possible alternative sources may include new or previously unknown CCR constituent sources, nearby source areas, laboratory or sampling causes, statistical evaluation causes, or natural variation. If the value can be attributed to one of these alternative sources and was not caused by an SSL directly related to impacts from the CCR Unit, then an alternate source demonstration (ASD) can be completed. An ASD must be certified by a qualified Professional Engineer and completed in writing within 90 days of completing the statistical evaluation for a particular sampling event.

4.0 REFERENCES

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