REPORT

40 CFR PART 257 GROUNDWATER MONITORING PLAN

Meramec Energy Center

St. Louis County, Missouri, USA

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1.0 INTRODUCTION

This Groundwater Monitoring Plan (GMP) presents information on the design of the groundwater monitoring system, groundwater sampling and analysis procedures, and groundwater statistical analysis methods for Ameren Missouri's (Ameren) Meramec Energy Center (Facility) in St. Louis County, Missouri (see location on **Figure 1**). The Meramec Energy Center currently manages and has historically managed Coal Combustion Residuals (CCR) generated from the facility at a number of surface impoundments. The surface impoundments onsite consist of:

- Active Surface Impoundments
  - Surface Impoundment 492 (MCPA), approximately 6 acres
  - Surface Impoundment 493 (MCPB), approximately 6 acres
  - Surface Impoundment 496 (MCPC), approximately 10 acres
  - Surface Impoundment 498 (MCPD), approximately 17 acres
  - Surface Impoundment 489 (MCPE), approximately 24 acres
- Excluded Surface Impoundments
  - Surface Impoundment 490 (MOPF), approximately 23 acres
  - Surface Impoundment 491 (MOPG), approximately 12 acres
  - Surface Impoundment 494 (MOPH), approximately 31 acres
  - Surface Impoundment 495 (MOPI), approximately 16 acres

According to the CCR Rule, all of the Meramec Surface Impoundments are unlined. However, Surface Impoundments 489 and 498 do have a liner in place. Since all the surface impoundments lie very close to one another and dividing berms were constructed with locally derived alluvial material and Coal Combustion Residuals (CCR), the monitoring network design monitors the Meramec Surface Impoundments as one multi-unit system.

This GMP 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 CCR Rule). The CCR Rule requires owners or operators of an existing CCR Surface Impoundment to install a groundwater monitoring system and develop a sampling and analysis program (§§ 257.90 - 257.94). Ameren Missouri has determined that the CCR Surface Impoundments at the Meramec Energy Center are subject to the requirements of the CCR Rule. For this GMP, the Meramec Energy Center generating plant is referred to as the MEC and the MEC and its surrounding facilities, including the Meramec Surface Impoundment, are referred to as the Facility or Site.

2.0 SITE SETTING

Ameren owns and operates the Facility in St. Louis County, Missouri located approximately 18 miles southwest of downtown St. Louis**.** **Figure 1** depicts the location of the Facility and property boundaries referenced to local topographic features, the Mississippi River, and the Meramec River. **Figure 2** depicts Facility structures relative to site property boundaries and the two adjoining rivers. The Facility property encompasses approximately 480 acres and is primarily located in the topographically low area north of the confluence of the Mississippi and Meramec Rivers. The property is bounded to the northeast by wooded and partially developed land, to the southeast by the Mississippi River, to the southwest and west by the Meramec River and to the northwest by wooded and partially developed land.

The Facility is located in a topographically low area in a valley at the confluence of the Meramec and Mississippi Rivers, with a surface elevation of approximately 420 feet above mean sea level (MSL) at the plant area. Topographically higher terrain is located west of the Meramec River Valley. The terrain to the east of the Facility consists of topographically higher terrain, at elevations generally ranging from 450 MSL feet to as high as 550 feet MSL, as shown on **Figure 2** and **Appendix A**.

2.1 Coal Combustion Residuals (CCR) Surface Impoundments

The Facility includes a coal fired power plant as well as five (5) currently active CCR surface impoundments that are used for CCR management. Historically, CCR has also been stored in four (4) additional surface impoundments, which are no longer ponded and are excluded from the CCR Rule groundwater monitoring requirements. A list of the Meramec Surface Impoundments is provided above in Section 1.0.

The present Site grade is as much as 20 feet above the original ground surface. As part of the MEC plant construction project, the original grade of the plant was increased by using fill material. The ash ponds were reportedly made by excavating on-Site material silts and clays and using the materials as construction fill beneath the plant as well as for surface impoundment berms (CH2MHILL, 1997). Reportedly, the Meramec Surface Impoundments were excavated approximately 10-20 feet below the original grade and then were used to contain the CCR. Therefore, present day ash thickness is reported to be typically 20 to 30 feet below the present Site grade, which is considered to be nominally at approximately 420 feet MSL (CH2MHILL, 1997). Based on this information, the generalized elevation of the base of the coal ash is estimated to be approximately 390 feet MSL. A cross section drawn through Ash Ponds 489 and 491 indicate the elevation of the base of ash is 390 feet MSL and 395 feet, respectively (CH2MHILL 1997, **Appendix B**).

CCR thickness was directly measured at three locations in Surface Impoundment 494 to be at least 26.5 feet thick (Golder, 2008) and at an elevation as low as approximately 387 feet MSL. CCR thickness was measured at two locations in Surface Impoundment 489 (Woodward-Clyde Consultants, 1988). The bottom of ash elevations were estimated to be 387.3 and 389.1 feet MSL.

While according to the CCR Rule all of the Meramec Surface Impoundments are treated as unlined units, Surface Impoundment 498 has a geomembrane liner with a base elevation of approximately 395 feet MSL (Ameren drawing SK-005-R2, 2011) and Surface Impoundment 489 is lined with a geomembrane with a base at an elevation of approximately 408 feet MSL (Ameren drawing 8020-X-135358, 1994). See **Appendix B** for referenced drawings.

2.2 Geology

2.2.1 Physiographic Setting and Regional Geology

The Facility is located in the extreme southeastern corner of the Central Lowland Physiographic Province and the Dissected Till Plains (Miller et al., 1974). However, the Facility lies between two major river systems near their confluence and within the floodplain of the Mississippi and Meramec Rivers in an area that contains alluvial river deposits. Therefore, the local site landforms are characterized by alluvial flood plain landforms.

2.2.2 Local Geology

The geology immediately surrounding the Facility is comprised of two distinctly different geological terrains; (1) floodplain deposits of the Mississippi and Meramec River Valleys and (2) older sedimentary bedrock formations. Most of the Facility, including all of the plant infrastructure and the Meramec Surface Impoundments lie within these floodplain deposits. The river valley area is comprised of floodplain and alluvial deposits that are the result of the water flow and deposition of the Mississippi and Meramec Rivers.

Based on previous investigations, the alluvial materials on the east side of the Facility tend to have more clayey silts, silty clays, and fine sands (CH2MHILL, 1997). Alluvial materials to the west, closer to the Meramec River, include coarser materials, including fine- to medium-grained sand with clay, silt, and some gravels (CH2MHILL, 1997). The depth of the alluvial deposits near the MEC range from approximately 105 to 120 feet below ground surface (bgs) and become shallower towards the bluffs to the northeast.

Shannon and Wilson (1979) completed a geotechnical investigation in the area directly around the MEC. 16 geotechnical borings were completed as a part of this investigation. Based on borings and cross sections from this report, the local geology directly adjacent to the MEC is as follows:

- Approximately 420-410 feet MSL – Fill Materials
- Approximately 410-375 feet MSL – Clays, Clayey Silts, and Silty Clays
- Approximately 375-340 feet MSL – Silts, Sandy Silts, Silty Sands, and Sands that thicken to the southeast towards the Mississippi River
- Approximately 340-320 feet MSL – Clays and Silty Clays
- Approximately 320-310 feet MSL – Intermittent Sands, Gravels, and Clayey Gravels
- Approximately 310 feet MSL and below – Limestone and Shale Bedrock

Drilling completed as a part of installation of the monitoring well network used for this GMP show similar results to previous studies. Borings located to the southwest of the MEC (MW-5, MW-6 and MW-7) encounter poorly and well graded sands that are likely associated with past meanders of the adjacent Mississippi and Meramec Rivers. The sand in these wells becomes more prevalent at locations closer to the Mississippi River to the south/southeast. Drilling completed further from the Mississippi River to the northwest consisted of more fine-grained materials such as silts, clays and silty clays with occasional sandy/gravelly lens deposits. These deposits are typical for low energy floodplain deposits with occasional sandy/gravel units from historical Meramec River channel meanders.

Bedrock beneath the Facility consists of the Warsaw Formation, of the Mississippian aged Meramecian Series and consists of shales and fine-grained shaley limestone (CH2MHILL, 1997). The bluff area on the east side of the Facility consists of the Salem Formation at lower elevations and St. Louis Limestone at higher elevations (Middendorf and Brill, 2002).

2.3 Site Hydrogeology

Site hydrogelogy has been characterized based on data collected during several different investigations. In 1988, five (5) monitoring wells were installed around the MEC by Woodward-Clyde Consultants (Woodward-Clyde). A map of the monitoring wells is provided in **Appendix C**. Observations from these five groundwater monitoring wells is summarized below. CH2MHill (1997) also completed a hydrogeological assessment using the monitoring wells installed by Woodward Clyde.

Golder (2008) installed five (5) piezometers both in and directly adjacent to Surface Impoundment 494. This effort provides information on the depth of ash in the Meramec Surface Impoundments, geotechnical data of the soil in and around the Meramec Surface Impoundments, and water level information in and around the Meramec Surface Impoundments.

Golder also installed ten (10) monitoring wells and borings as a part of the installation of the CCR monitoring well network used for CCR monitoring. **Appendix A** provides cross section depictions of the subsurface geology. Boring logs and monitoring well construction diagrams are provided in **Appendix D** and **Appendix E**.

2.3.1 Uppermost Aquifer

The CCR Rule requires that a groundwater monitoring system be completed in the uppermost aquifer around each Active CCR Surface Impoundment (§257.91(a)). As shown on **Appendix A**, the uppermost aquifer is the alluvial silt, sand and gravel deposits associated with the Meramec and Mississippi River Valley alluvium (CH2MHILL, 1997; Shannon & Wilson, 1979; **Appendix C**). These channel deposits are intermixed with a wide variety of clay/silty clay floodplain deposits and, therefore, can appear at varying

depths. However, sandy/gravelly units were encountered at many locations at approximately 360-370 feet MSL, likely deposited from a historic meander of the Meramec River. These alluvial deposits overlie Mississippian-age limestone and shale of the Meramecian Series. The depth of the alluvial aquifer typically ranges from approximately 105 to 120 feet bgs (approximately 255 to 331 feet MSL), but thins to the east toward the bluff (CH2MHILL, 1997), where it is not present at higher elevations above the floodplain.

2.3.2 Surface Water and Groundwater Elevations

2.3.2.1 CCR Surface Impoundment Water

Meramec pond gauge measurements were provided by Ameren for Surface Impoundments 498, 492, 493, and 496. These measurements were obtained during a similar timeframe as the groundwater measurements from each of the 8 initial background sampling events (baseline events). During this time, Surface Impoundment 498 had a pond level ranging from approximately 417 to 418 feet MSL. This pond has a liner system in place and does not connect with the underlying aquifer or surrounding surface impoundments. The pond level in Surface Impoundments 492, 493, and 496 ranged between approximately 408 and 412 feet MSL. These Surface Impoundments ranged between 9 to 30 feet above the natural groundwater elevations in the surrounding aquifer. The difference between the pond level and the natural groundwater elevation is greatest when the Mississippi River level is low. Data show water mounding within the Meramec Surface Impoundments without a liner regardless of the river level; however, the mounding is less pronounced at times of high river level.

2.3.2.2 Alluvial Aquifer

Groundwater elevations within the alluvial aquifer in the Facility area have been obtained in several different studies. Historical groundwater measurements come from five (5) monitoring wells installed in 1988 by Woodward-Clyde and then re-analyzed in 1997 by CH2MHILL. Three of the monitoring wells (B-4, B-5, and B-6) were installed with total depths ranging from 90 and 101 feet bgs. These three (3) monitoring wells were located near Surface Impoundment 489 at the southwest corner of the Facility, near the Meramec River. Groundwater elevations in the downgradient monitoring wells near Surface Impoundment 489 ranged between approximately 377 and 385 feet MSL and were similar to the concurrent Mississippi River level. Monitoring wells B-1 and B-2 were installed on the east (upgradient) side of the Facility with total depths ranging from 41 to 56 feet bgs. Groundwater elevations in these monitoring wells ranged from approximately 403 to 415 feet MSL and were typically 20 to 30 feet higher in elevation than the Mississippi River. Additionally, one monitoring well (B-7) was installed into the coal ash to a total depth of 389 feet MSL and was dry in all readings (Woodward-Clyde Consultants, 1988). Results from these groundwater elevation measurements are provided in **Appendix C**.

Golder obtained groundwater elevation measurements from March 2016 through June 2017 within the alluvial aquifer for the CCR monitoring wells. For each of the 8 baseline sampling events, groundwater

elevations were measured at monitoring wells within a 24-hour timeframe and a potentiometric map was generated from these data (**Appendix F and Table 1)**. Groundwater elevations ranged from approximately 380 to 400 feet MSL throughout the baseline sampling events except at MW-1, which ranged from approximately 400 to 404 feet MSL.

2.3.3 Groundwater Flow Directions

Groundwater flow within the alluvial aquifer is dynamic and is influenced by seasonal changes in the water level in the adjacent Mississippi and Meramec Rivers. River water levels measured at the Facility display large seasonal changes in the elevation of the Mississippi River water surface. For example, from January 2010 to April 2017, river water levels fluctuated between approximately 365 to 413 feet MSL. 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 have a flow direction component toward the Mississippi and Meramec Rivers, with a net flow direction generally to the southwest.

Although the movement of groundwater within the alluvial aquifer at the Facility is complex, the movement has been characterized by groundwater elevation measurements and the generation of potentiometric surface maps generated by Woodward-Clyde and Golder (**Appendix C, Appendix F, and Table 1**). The potentiometric surface maps display minor variability in the groundwater flow direction. These changes in flow direction are related to the level within the adjacent Mississippi and Meramec Rivers.

Groundwater flow direction and hydraulic gradient were estimated for the CCR wells using the EPA’s On-line Tool for Site Assessment (USEPA, 2016). Estimated results from this analysis using groundwater elevations within the CCR monitoring wells are provided in **Table 2**. These results indicate that while groundwater flow direction is somewhat variable, overall net groundwater flow during the baseline sampling period was generally toward the west/southwest, flowing from the bluffs toward the rivers.

Based on the potentiometric surface maps and groundwater calculations, a general flow direction from the northeast (bluffs) to the southwest (Mississippi and Meramec Rivers) under normal river conditions is expected. However, during periods of high river levels, groundwater flow can temporarily reverse in localized areas. 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 north and east occurs.

Horizontal and vertical groundwater flow within the uppermost aquifer has been locally influenced by operation of the Meramec Surface Impoundments. Ponding of water in the Meramec Surface Impoundments that do not have a liner in place at elevations greater than the static water levels in the

underlying alluvial aquifer groundwater creates a localized mounding effect, resulting in localized downward gradients and localized radial groundwater flow downward and outward from these impoundments.

2.3.3.1 Horizontal Gradients

Horizontal groundwater gradients in the alluvial aquifer are very dependent on river water levels (bank recharge and bank discharge conditions described earlier). Site wide horizontal gradients were calculated for each of the CCR groundwater baseline sampling events and the results of these are displayed on **Table 2**. The horizontal groundwater gradients range from 0.001 to 0.003 feet/foot.

2.3.3.2 Vertical Gradients

A review of downward gradients that exist on site was completed by comparing groundwater elevations in the CCR monitoring wells to the Meramec Surface Impoundment pond gauges. On average, the groundwater elevation of the active ponds that do not have a liner (492, 493, and 496) is approximately 9 to 30 feet higher than the alluvial groundwater zone. However, this downward gradient also changes seasonally based on river levels. During high river level conditions, the difference in groundwater elevation between the surface impoundments and the alluvial groundwater zone is the smallest.

2.3.4 Hydraulic Conductivities

Golder performed in-situ rising head hydraulic conductivity tests on the 10 newly installed CCR monitoring wells used to monitor the Meramec Surface Impoundments in order to estimate the hydraulic conductivities. The tests were conducted using a pneumatic slug (Hi-K slug) and a downhole pressure transducer. The results of Golder's hydraulic conductivity testing estimated an average hydraulic conductivity of approximately 2.3 x 10^{-2} centimeters per second (cm/sec) and a geometric mean of 1.4 x 10 of $^{-2}$ cm/sec. Golder's findings for hydraulic conductivity values are summarized below in **Table 3** provided below in the text.

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, flow velocities are estimated to range between 0.13 and 0.34 feet per day, and approximately 87 feet per year.

Table 3: CCR Monitoring Well Hydraulic Conductivities

Well ID	Total Depth (feet BTOC)	Well Screen Interval (feet BTOC)	Well Screen interval (feet MSL)	Estimated Hydraulic Conductivity (feet/day)	Estimated Hydraulic Conductivity (cm/sec)
MW-1	41.4	36.2 - 41.0	365.4 - 370.2	85	3.00E-02
MW-2	36.8	31.6 - 36.4	362.2 - 367.0	92	3.26E-02
MW-3	33.1	27.9 - 32.7	364.4 - 369.2	185	6.52E-02
MW-4	45.2	40.0 - 44.8	359.3 - 364.1	46	1.63E-02
MW-5	62.7	52.5 - 62.3	340.6 - 350.4	56	1.98E-02
MW-6	54.9	44.7 - 54.5	363.6 - 373.4	37	1.32E-02
MW-7	54.9	44.7 - 54.5	363.4 - 373.2	49	1.74E-02
MW-8	77.8	67.6 - 77.4	346.0 - 355.8	5	1.89E-03
BMW-1	62.89	52.7 - 62.5	356.6 - 366.4	3	9.91E-04
BMW-2	44.9	39.7 - 44.5	364.5 - 369.3	106	3.75E-02

Notes:
1. feet BTOC – feet below top of casing ft BGS - feet below ground surface.
2. feet MSL - feet above mean sea level.
3. cm/sec - centimeters per second.
4. Slug tests were completed by Golder Associates using a Pneumatic Hi-K Slug®.

2.3.5 Porosity and Effective Porosity

Porosities were estimated based on the grain size distributions of aquifer soil samples collected during monitoring well drilling. Representative grain size distributions were collected from the screened intervals at MW-6 and MW-8 using the ASTM D6912 Method B and the results are provided in **Appendix G**. MW-6 represents monitoring wells that were located closer to the Mississippi River and had more sandy environments, whereas MW-8 represents wells that contained gravel/silty sand environments that were further from the Mississippi and are historical Meramec River channels. The results indicate that the screened intervals of the alluvial aquifer near the Mississippi River are mostly comprised of sand (at least 90%) with lesser amounts of gravel, silt and clay. Also, the typical grain size of the sand ranges from fine to medium 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 NETWORK

3.1 Monitoring Network Design Criteria

§257.91 of the CCR Rule sets out the requirements for development of a groundwater monitoring system for both new and existing CCR landfills and surface impoundments. The performance standard in the CCR Rule (§257.91(a)) states that the groundwater monitoring system must consist of a sufficient number of wells at appropriate locations to yield groundwater samples in the uppermost aquifer that accurately represent:

- The quality of background groundwater
- The quality of groundwater passing the waste boundary of the CCR unit

3.2 Design of the Groundwater Monitoring System

The detection monitoring well network for the Facility is depicted on **Figure 2**. The network consists of 10 monitoring wells screened in the uppermost aquifer for the purpose of monitoring the Meramec Surface Impoundments. The monitoring well network includes two (2) background groundwater monitoring wells (BMW-1 and BMW-2) that are located on the bluff side of the facility in areas upgradient and unaffected by CCR disposal. BMW-1 is located near the bluffs on the southeastern portion of the site and BMW-2 is located near the bluffs on the northeastern portion of the site. Eight (8) of the groundwater monitoring wells are placed ringing the Meramec Surface Impoundments and are downgradient wells. The groundwater monitoring well locations were selected based on site-specific technical information presented in Section 2.0 of this document, as well as the preferential migration pathway analysis below.

3.2.1 Preferential Migration Pathway Analysis

As discussed in Section 2.3, the movement of constituents in water from the ash within the Meramec Surface Impoundments will be downward and predominately in the downgradient direction toward the Meramec and Mississippi Rivers. Groundwater elevations are higher to the east and lower to the west/south, and fluctuate with river stages. CCR is known to be at least 28 feet thick, placing it at an approximate base elevation of 385 to 390 feet MSL. Groundwater levels onsite in downgradient wells typically range from 380 to 385 feet MSL under normal river conditions and can be as high as 395 feet MSL or higher during high river conditions. Upgradient wells range from 390 to 400 feet MSL. The potential exists for constituents to migrate from the Meramec Surface Impoundments into the alluvial aquifer from depths ranging from the water table surface down to the lowest depth of CCR, followed by lateral movement in the direction of groundwater flow. Geologically, the preferential pathway for groundwater is through zones with the highest conductivity and flow. The highest conductivity layers on-site are those comprised of coarse-grained particles such as sand, gravel and silty sands. Groundwater in these units will have higher dispersivity.

In order to place monitoring well screens within the migration pathway from the unit and to consistently have water for sampling, monitoring wells were installed with screen intervals below the seasonal groundwater lows and placed with screening levels that intercept water from the units with the greatest hydraulic conductivity and flow. The system of monitoring wells ringing the Meramec Surface Impoundments are screened in the uppermost unit and monitor groundwater quality passing the waste boundary.

3.3 Groundwater Monitoring Well Placement

3.3.1 Background/Upgradient Monitoring Well Locations

As described above, the flow of groundwater in the alluvial aquifer is generally from the bluff area located northeast of the site toward the Mississippi and Meramec Rivers to the south and west, however, alluvial aquifer flow is locally influenced by water levels in the active surface impoundments without a liner (492, 493, and 496) and the Mississippi and Meramec River levels. The CCR Rule (§257.91(a)(1)) requires that background groundwater samples from the uppermost aquifer *"Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit."*

As shown in **Figure 2**, the background monitoring wells BMW-1 and BMW-2 are located close to the bluff on the eastern side of the Facility. BMW-1 is located to the southeast of the Meramec Surface Impoundments and BMW-2 is located to the northeast of the Meramec Surface Impoundments. These wells provide background groundwater quality representative of upgradient groundwater that will pass through the Meramec Surface Impoundments.

3.3.2 Downgradient Monitoring Well Locations

As discussed above, downgradient monitoring wells are located ringing the Meramec Surface Impoundments to monitor potential migration pathways. **Figure 2** shows that the downgradient well network consists of eight (8) groundwater monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, and MW-8) around the Meramec Surface Impoundments at locations that are located as close to the waste boundary as practical.

3.3.3 Groundwater Monitoring Well Screen Intervals

The system of monitoring wells ringing the Meramec Surface Impoundments are screened in the alluvial aquifer zone near the base elevation of the CCR. Details on the construction of the groundwater monitoring wells are provided in **Table 4** and **Appendix E.**

Screen intervals were installed within the uppermost high conductivity unit within the alluvial aquifer at each location that was below the seasonal low for groundwater. Each well has an approximately 5- or 10-foot-long screen interval. Screen intervals for the CCR Wells range from approximately 341 to 374 feet MSL

(approximately 25 to 75 feet bgs). Monitoring well construction information is shown in **Table 4** and **Appendix E**.

4.0 INSTALLATION OF THE GROUNDWATER MONITORING SYSTEM

The CCR Rule Groundwater Monitoring System for the Meramec Surface Impoundments was installed in January 2016 and April 2016 as described in the following subsections.

4.1 Drilling Methods and Monitoring Well Constructions

Cascade Drilling LP installed the monitoring wells using a rotosonic drill rig (Mini Sonic CDD 1415) under direct supervision of a Golder Geologist or Engineer. Continuous soil core samples were obtained at each well borehole location and were logged in the field by Golder. Soils were classified according to the Unified Soil Classification System. Boring logs and well construction diagrams are provided in **Appendix D** and **Appendix E** respectively.

Groundwater monitoring wells were installed in accordance with Missouri Department of Natural Resources (MDNR) Well Construction Rules (10 CSR 23-4.060 Construction Standards for Monitoring Wells). All groundwater monitoring wells were installed using 2-inch diameter PVC well riser pipe and 5 or 10-foot long, 0.010-inch machine slotted well screens. Wells were installed with a sand filter pack, bentonite seal, and annular space in accordance with MDNR Well Construction Rules. Details on the construction of the groundwater monitoring wells are provided in **Table 4** and **Appendix E**.

Monitoring wells were completed with an aluminum protective cover with a locking lid that extends approximately 2 to 3 feet above ground surface and a small concrete pad. Three yellow protective posts (concrete filled steel bollards) were installed around each monitoring well surface completion.

4.2 Groundwater Monitoring Well Development

After well construction, a Golder Geologist or Engineer developed groundwater monitoring wells using surging and purging techniques. During development, field parameters (pH, conductivity, temperature, and turbidity) were recorded and development was complete once a minimum of three well-bore volumes of water were purged, turbidity was typically less than 20 nephelometric turbidity units (NTU) or ± 10% and consecutive measurements of field parameter values were within 10 percent difference. Groundwater monitoring wells were developed using an inertial pump with a surge block ring attached to a foot valve to surge and purge the well. Well development forms are attached in **Appendix H**.

4.3 Dedicated Pump Installation

A dedicated pump was installed in each groundwater monitoring well after development and hydraulic conductivity testing. The dedicated pumps provide a consistent, repeatable sampling method to reduce likelihood of cross contamination, reduce water sample turbidity, and expedite sampling. For the purposes of this groundwater monitoring network, low-flow QED brand PVC MicroPurge bladder pumps with Dura-Flex Teflon bladders were installed in each well.

4.4 Surveying and Well Registration

Zahner and Associates, Inc., a Professional Land Surveyor licensed in Missouri, surveyed the location and top of casing elevation of the monitoring wells. A drawing showing the location of the groundwater monitoring wells is shown in **Figure 2** and a summary of survey information is provided in **Table 4**. Upon completion of monitoring well installation and surveying, MDNR Well Construction Registration Forms were prepared for each well and submitted to MDNR. Copies of these forms are provided in **Appendix I**.

5.0 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program for the Meramec Surface Impoundments is described in the following sections.

5.1 Baseline Sampling Events

In accordance with section 257.94(b) of the CCR Rule, before starting detection monitoring, eight baseline (or background) samples were collected for all Appendix III and Appendix IV parameters at all downgradient and upgradient/background monitoring wells prior to October 17, 2017. These samples establish initial baseline datasets that are used for the statistical evaluation of groundwater results.

5.2 Detection Monitoring

The Detection Monitoring Program is defined in the CCR Rule in section 257.94 and the following sections outline the procedures for the detection monitoring program.

5.2.1 Sampling Constituents and Monitoring Frequency

Detection monitoring should be completed at a minimum of semi-annually (approximately every 6 months) for all Appendix III constituents (**Table 5**) unless a demonstration that the need for an alternative monitoring schedule is required. **Table 6** lists the analytical methods and practical quantitation limits used for the monitoring program.

5.2.2 Data Evaluation and Response

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. The data will be analyzed using the methods and procedures outlined in the statistical analysis plan (**Appendix J**).

5.3 Assessment Monitoring

Assessment monitoring is outlined in section 257.95 of the CCR Rule and is initiated after a confirmed SSI has been identified and no alternate source demonstration has been completed. In accordance with the CCR Rule, a notification must be prepared and placed within the Facility operating record and on the publically available website stating that an Assessment Monitoring program has been initiated. The purpose of Assessment Monitoring is to determine whether or not groundwater concentrations are at a Statistically Significant Level (SSL) compared to Groundwater Protection Standards (GWPS). Detection Monitoring sampling continues during Assessment Monitoring.

5.3.1 Sampling Constituents and Monitoring Frequency

As outlined in section 257.95 of the CCR rule, Assessment Monitoring groundwater sampling must begin within 90 days of a confirmed SSI determination. Sampling must be completed at all monitoring wells used in the detection monitoring program, for all Appendix IV analytes (**Table 5**). Within 90 days of receiving

data from this initial Assessment Monitoring sampling event, a second sampling event must be completed analyzing the Appendix IV constituents detected in groundwater during the initial sampling event.

Following this initial phase of the Assessment Monitoring Program, the CCR Rule requires sampling of the full list of Appendix IV constituents on an annual basis (Annual Assessment Event). During the other semi-annual Assessment Sampling Event, only those Appendix IV constituents that are detected during the annual sampling event are to be analyzed and reported. Additionally, verification resampling will be performed within 90 days of receiving data from the laboratory for all detected Appendix IV constituents for each event.

5.3.2 Data Evaluation and Response

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. The data will be analyzed using the methods and procedures outlined in the Statistical Analysis Plan (**Appendix J**).

A GWPS is required for each Appendix IV constituent and must be included in the annual report. The GWPS will be either the MCL or a value based on background data, whichever is higher. The generation of the GWPS is discussed in more detail in the Statistical Analysis Plan (**Appendix J**). Statistical analysis must be completed within 90 days of receiving data from the laboratory. The statistical analysis will determine if any constituents are SSLs greater than the GWPS.

In order to discontinue Assessment Monitoring and return to Detection Monitoring, the concentration of all Appendix III and Appendix IV constituents for all compliance wells must be at levels statistically lower than background levels for two consecutive sampling events (257.95(e)). If any constituent is present at a statistical level above background levels, but below the GWPS, then Assessment Monitoring continues.

5.3.2.1 Responding to a SSL

If the Assessment Monitoring statistical evaluations demonstrate that a SSL has been triggered, then the owner/operator of the CCR unit must complete the following four actions as described in 257.95(g):

1. Prepare a notification identifying the constituents in Appendix IV that have exceeded a CCR Unit specific GWPS. This notification must be placed in the facility operating record within 30 days of identifying the SSL (257.95(g)) and 257.105(h)). Additionally, within 30 days of placing the notification in the operating record, the notification must be posted to the internet site (257.107(h)).
2. Define the character and extent of the release and any relevant site conditions that may affect the corrective action remedy that is ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up releases from the CCR Unit and must include at least the following: (No timeframe is specified in the CCR Rule for this action)

A. Installation of additional monitoring wells that are necessary to define the contaminant plume

B. Collect data on the nature and estimated quantity of the material released

C. Install and sample at least one additional monitoring well at the facility boundary in the direction of the contaminant plume migration

3. Notify off-site property owners if the contamination plume has migrated offsite on to their property within 30 days of this determination.

4. If possible, provide an alternate source demonstration that determines that the SSL is not caused by a release at the facility within 90 days of completing the statistical evaluation. If no alternate source demonstration can be made and the plume is determined to have originated from the CCR Unit, then proceed to corrective action steps in the CCR Rule.

D. If no alternate source demonstration is made, and the CCR Unit is an unlined surface impoundment, the closure or retrofit must be initiated.

Actions 1-3 must be completed regardless of whether or not an alternate source demonstration can be made.

5.3.3 Annual Reporting Requirements

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) and downgradient monitoring wells included in this monitoring plan
- 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
- 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 monitoring or assessment monitoring programs
- 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
- If required, a demonstration that an alternate sampling frequency is needed
- If assessment monitoring is required, a listing of GWPS for each Appendix IV constituent

6.0 GROUNDWATER SAMPLING METHODOLOGY

Sampling will be performed in accordance with generally accepted practices within the industry and with the provisions of Missouri regulations. The following sections provide details regarding procedures that will be used to collect groundwater samples. Although this section provides reference to specific forms, the use of other equivalent forms to record the necessary data is permissible.

6.1 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 K**.

6.2 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.

6.3 Water Level Measurement

To meet the requirements of §257.93(c), water level measurements will be taken at all monitoring wells and prior to the start of any groundwater purging. 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 (included in **Appendix I**). 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.

6.4 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

6.4.1 Low-Flow Sampling Technique

Low-flow groundwater sampling procedures will be used for purging and sampling monitoring wells that are equipped with dedicated pumps 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 will be considered 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.

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, collecting 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 K**.

6.4.2 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.

6.4.3 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 bottles, samplers will note this on the field form, and fill as many sample bottles as possible.

6.5 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 as listed in **Table 6**. Sample containers will be kept closed until the time each set of sample containers is filled.

6.6 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 gloves will be worn by sampling personnel during monitoring well purging and sample collection.

6.7 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.

6.8 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 K**.

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.

6.8.1 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

6.8.2 Sample Seal

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

6.8.3 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 J**. The field forms will document the following information:

- Identification of the monitoring well
- Sample identification number
- Field meter calibration information
- Static 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

6.8.4 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 his possession
- It was in the individual's possession and he 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.

6.9 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.

7.0 ANALYTICAL AND QUALITY CONTROL PROCEDURES

7.1 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).

7.2 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.

7.2.1 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.**

7.2.2 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.**

7.2.3 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.**

7.2.4 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: M-MW-1
- MS: M-MW-1-MS
- MSD: M-MW-1-MSD

8.0 DATA EVALUATION AND STATISTICAL ANALYSIS

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

8.1 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.

8.2 Data Validation

Before the data are used for statistical analysis, they will be evaluated by examining the quality control data accompanying the data report from the laboratory. 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 any anomalous data.

8.3 Statistical Analysis

Upon completion of the data validation, the data will be submitted for statistical analysis in compliance with 40 CFR §257.93. The detailed statistical analysis plan for the Facility will be included in **Appendix J**.

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TABLES

Table 1
Groundwater Level Data
Meramec Surface Impoundments
Meramec Energy Center, St. Louis County, MO

Well ID	Location[4]		Top of Casing[7]	Ground Surface[7]	Background Event 1 3/28/2016		Background Event 2 5/13/2016		Background Event 3 7/18/2016		Background Event 4 9/7/2016		Background Event 5 11/10/2016		Background Event 6 1/6/2017		Background Event 7 3/7/2017		Background Event 8 6/14/2017	
	Northing	Easting	Feet MSL[5]	Feet MSL[5]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]	DTW[3]	GWE[4]
MW-1	937676.9	865954.1	406.43	404.1	4.83	401.60	2.61	403.82	5.57	400.86	4.72	401.71	5.36	401.07	7.08	399.35	5.55	400.88	2.46	403.97
MW-2	937325.1	864864.5	398.62	396.1	12.76	385.86	3.54	395.08	14.79	383.83	11.69	386.93	16.42	382.20	19.10	379.52	13.25	385.37	7.72	390.90
MW-3	936750.8	864447.2	397.12	394.6	11.30	385.82	2.07	395.05	13.27	383.85	10.15	386.97	14.93	382.19	17.62	379.50	11.81	385.31	6.23	390.89
MW-4	935618.0	864629.8	404.10	402.0	18.17	385.93	9.13	394.97	20.02	384.08	16.48	387.62	21.65	382.45	24.43	379.67	18.93	385.17	13.08	391.02
MW-5	934874.4	864781.0	402.93	400.8	16.94	385.99	7.93	395.00	18.67	384.26	15.65	387.28	20.27	382.66	23.14	379.79	17.83	385.10	11.69	391.24
MW-6	933905.2	865153.5	418.12	415.8	32.26	385.86	23.33	394.79	33.56	384.56	30.56	387.56	35.11	383.01	38.29	379.83	33.64	384.48	26.49	391.63
MW-7	934334.4	866242.5	417.94	415.7	32.01	385.93	23.04	394.90	33.32	384.62	30.37	387.57	34.68	383.26	37.79	380.15	33.52	384.42	26.39	391.55
MW-8	935303.6	866797.8	423.37	421.0	36.68	386.69	27.46	395.91	38.07	385.30	35.14	388.23	39.60	383.77	42.59	380.78	37.57	385.80	31.27	392.10
BMW-1	935220.4	867989.4	419.08	416.8	24.40[8]	396.72[8]	19.78	399.30	28.16	390.92	24.96	394.12	27.41	391.67	32.64	386.44	28.51	390.57	22.49	396.59
BMW-2	937927.1	866342.2	409.02	406.8	14.21	394.81	11.22	397.80	15.45	393.57	14.58	394.44	15.36	393.66	17.29	391.73	15.71	393.31	11.39	397.63
Mississippi River	934893.52[2]	868520.62[2]	NA	NA	NA	386.59	NA	395.52	NA	384.25	NA	387.53	NA	382.37	NA	380.70	NA	385.77	NA	390.10

Notes:
1.) Groundwater monitoring wells surveyed by Zahner & Associates, Inc. on February 4, 2016 and April 28, 2016.
2.) * - Mississippi River gauge location is estimated.
3.) DTW - Depth to water measured in feet below top of casing.
4.) GWE - Groundwater elevation measured in feet above mean sea level.
5.) MSL - Feet above mean sea level.
6.) Horizontal Datum: State Plane Coordinates NAD83 (2000) Missouri East Zone feet.
7.) Vertical Datum: NAVD88 feet.
8.) Groundwater elevation data based on orginal BMW-1 location that has been abandoned.
9.) NA - Not Applicable.
10.) Mississippi River Level is provided by Ameren.

Prepared JSI
Check JS/RJF
Reviewed MNH

Generalized Hydraulic Properties of Uppermost Aquifer
Meramec Surface Impounments
Meramec Energy Center, St. Louis County, MO

Meramec Monitoring Wells (MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, BMW-1, BMW-2)							
Baseline Sampling Event	Baseline Sampling Event Date	Average Groundwater Flow Direction (Azimuth)	Estimated Hydraulic Gradient (Feet/Foot)	Mean Hydraulic Conductivity (Feet/Day)	Mean Hydraulic Conductivity (cm/sec)	Estimated Effective Porosity	Estimated Groundwater Velocity (Feet/Day)
1	3/28/2016	232.5	0.0022	37.02	1.3E-02	0.35	0.23
2	5/13/2016	249.1	0.0012	37.02	1.3E-02	0.35	0.13
3	7/18/2016	240.1	0.0025	37.02	1.3E-02	0.35	0.27
4	9/7/2016	244.8	0.0022	37.02	1.3E-02	0.35	0.23
5	11/10/2016	242.3	0.0032	37.02	1.3E-02	0.35	0.34
6	1/6/2017	233.9	0.0030	37.02	1.3E-02	0.35	0.31
7	3/7/2017	230.9	0.0023	37.02	1.3E-02	0.35	0.24
8	6/14/2017	244.0	0.0019	37.02	1.3E-02	0.35	0.20

Estimated Results (USEPA Tool)	
Resultant Groundwater Flow Direction (Azimuth)	239
Estimated Annual Net Groundwater Movement (Feet/Year)	87

Prepared By: JSI
Checked By: JS/RJF
Reviewed By:

Notes:

1. Azimuth and Hydraulic Gradient calculated using the United States Environmental protection agency (USEPA) On-Line Tools for Site Assessment Calculation for Hydraulic Gradient (magnitude and direction) available at https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/gradient4plus-ns.html
2. Hydraulic conductivity value is the geometric mean of slug test results for the Meramec monitoring wells (except MW-1).
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.

Table 4
Monitoring Well Construction Details
Meramec Surface Impoundments
Meramec Energy Center, St. Louis County, MO

Well ID	Date Installed	Location[4]		Top of Casing Elevation	Ground Surface Elevation	Top of Screen	Bottom of Screen	Base of Well	Total Depth
		Northing	Easting	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT MSL)[5]	(FT BGS)[5]
MW-1	1/23/2016	937676.9	865954.1	406.43	404.1	370.2	365.4	365.0	39.1
MW-2	1/23/2016	937325.1	864864.5	398.62	396.1	367.0	362.2	361.8	34.3
MW-3	1/22/2016	936750.8	864447.2	397.12	394.6	369.2	364.4	364.0	30.6
MW-4	1/22/2016	935618.0	864629.8	404.10	402.0	364.1	359.3	358.9	43.1
MW-5	1/22/2016	934874.4	864781.0	402.93	400.8	350.4	340.6	340.2	60.6
MW-6	1/21/2016	933905.2	865153.5	418.12	415.8	373.4	363.6	363.2	52.7
MW-7	1/24/2016	934334.4	866242.5	417.94	415.7	373.2	363.4	363.0	52.7
MW-8	1/24/2016	935303.6	866797.8	423.37	421.0	355.8	346.0	345.6	75.4
BMW-1	4/7/2016	935220.4	867989.4	419.08	416.8	366.4	356.6	356.2	60.6
BMW-2	1/25/2016	937927.1	866342.2	409.02	406.8	369.3	364.5	364.1	42.7

Notes:
1.) All elevations and coordinates were surveyed on January 14, and April 28th, 2016 by Zahner and Associates, Inc.
2.) FT MSL = Feet Above Mean Sea Level.
3.) FT BGS = Feet Below Ground Surface.
4.) Horizontal Datum: State Plane Coordinates NAD83 (2000) Missouri East Zone Feet.
5.) Vertical Datum: NAVD88 Feet.

Prepared By: JSI
Checked By: JS
Reviewed By: MNH

Table 5

Groundwater Quality Monitoring Parameters

Meramec Surface Impoundments

Meramec Energy Center, St. Louis County, MO

Monitoring Parameter		Background[2]	Detection[3]	Assessment[4]
Field Parameters	Temperature, pH, Conductivity and Dissolved Oxygen	X	X	X
Appendix III[1]	Boron	X	X	X
	Calcium	X	X	X
	Chloride	X	X	X
	Fluoride	X	X	X
	Sulfate	X	X	X
	pH	X	X	X
	Total Dissolved Solids (TDS)	X	X	X
Appendix IV[1]	Antimony	X		X
	Arsenic	X		X
	Barium	X		X
	Beryllium	X		X
	Cadmium	X		X
	Chromium	X		X
	Cobalt	X		X
	Fluoride	X		X
	Lead	X		X
	Lithium	X		X
	Mercury	X		X
	Molybdenum	X		X
	Selenium	X		X
	Thallium	X		X
	Radium 226 & 228	X		X

Notes:

1.) Analyte lists match requirements for monitoring from USEPA Rule 40 CFR parts 257 and 261.

2.) Background will be performed through October 2017 until at least 8 samples are collected.

3.) Approximately 6 months will separate each semi-annual sampling event.

4.) If necessary, assessment monitoring will be performed in accordance with USEPA Rule.

Prepared By: JS
Checked By: MWD
Reviewed By: MNH

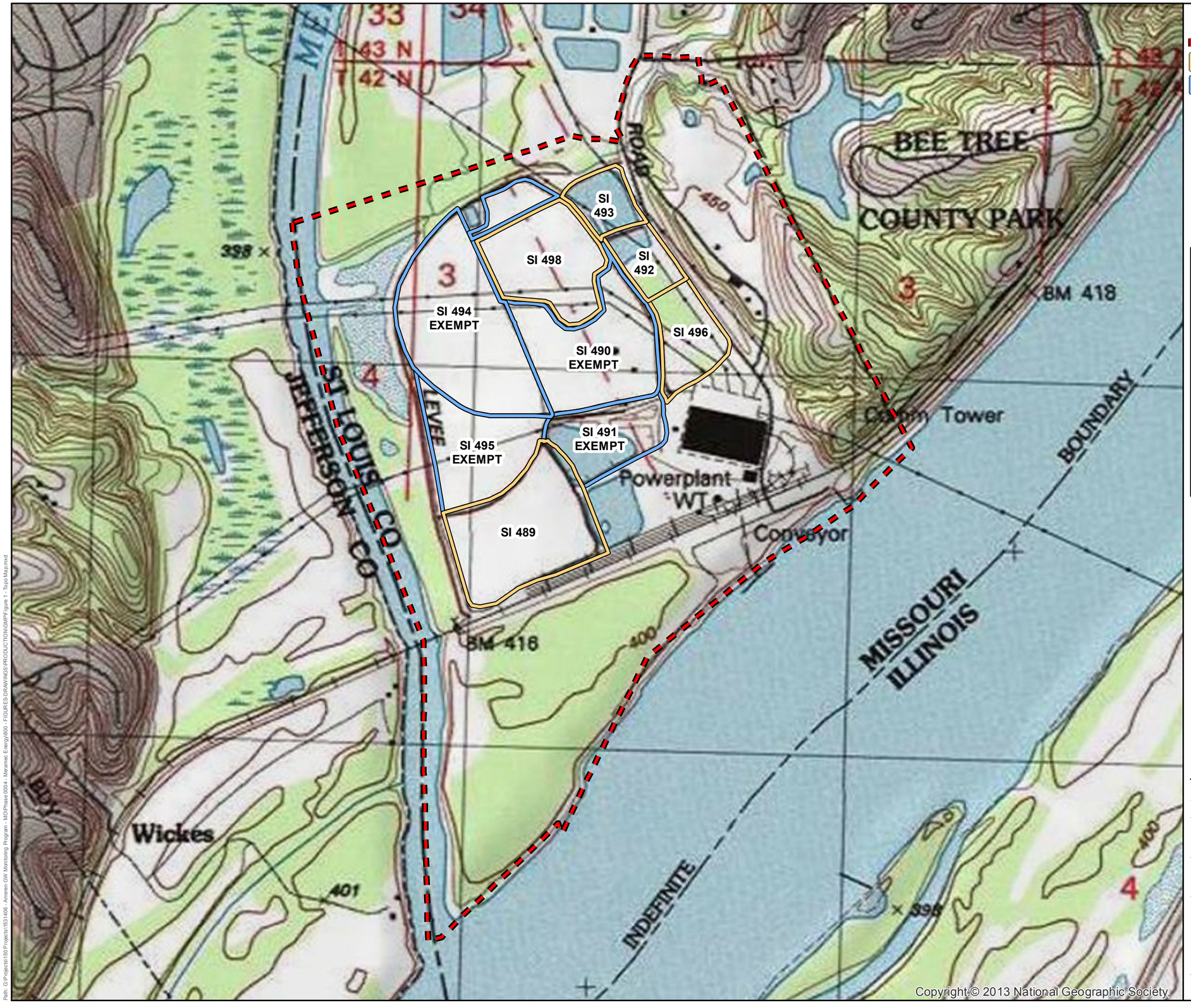
Table 6
Analytical Methods and Practical Quantitation Limits
Meramec Surface Impoundments
Meramec Energy Center, St. Louis County, MO

Analyte	Method Reference	Preservative	Hold Times	PQL (µg/L)	MCL (mg/L)
Appendix III - Detection Monitoring					
Boron	SW-846 6010/MCAWW 200.7	HNO3	6 months	20.0	NA
Calcium	SW-846 6010/MCAWW 200.7	HNO3	6 months	500.0	NA
Chloride	EPA 300.0/325.5/MCAWW 300/SW846 9251/9056	NA	28 days	500.0	NA
Fluoride	EPA 300.0, 300.1	NA	28 days	-	4
pH	4500 H+B-2000	NA	NA	-	NA
Sulfate	EPA 300.0/SW846 300	NA	28 days	2000.0	NA
Total Dissolved Solids (TDS)	2540 C-1997/SM18-20 2540 C	NA	7 days	10000.0	NA
Appendix IV - Assessment Monitoring					
Antimony	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.006
Arsenic	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.01
Barium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	2.0	2
Beryllium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.004
Cadmium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	0.5	0.005
Chromium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.5	0.1
Cobalt	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	4.0	NP
Fluoride	EPA 300.0	N/A	28 days	-	4
Lead	SW-846 6020	HNO3	6 months	0.005	0.015
Lithium	SW-846 6010	HNO3	6 months	-	NA
Mercury	SW-846 7470	HNO3	28 days	-	0.002
Molybdenum	SW-846 6010	HNO3	6 months	-	NP
Selenium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	1.0	0.05
Thallium	SW-846 6010/6020/MCAWW 200.7/200.8	HNO3	6 months	0.2	0.002
Radium 226 & 228	SW-846 903.1/SM 6500 904	-	-	1.0 (pCi/L)	5.0 (pCi/L)

Notes:
1.) NA - not applicable.
2.) Analyte lists matches requirements for detection and assesment monitoring from United States Environmental Protection Agency (USEPA) Rule 40 CFR parts 257 and 261.
3.) SW-846 denotes Test Methods for Evaluating Solid Waste, Physical- Chemical Methods, EPA publication SW-846, 3rd edition, and subsequent updates.
4.) MCAWW denotes Methods for the Chemical Analysis of Water and Wastes (MCAWW), United States Environmental Protection Agency (USEPA) published in the 1983.
5.) EPA 300 denotes Methods for the Determination of Organic Compounds in Drinking Water Environmental Monitoring Systems Laboratory, Office of Research and Development, USEPA, Cincinnati, Ohio 45268. EPA-300/4-88/039, December 1988 (Revised July 1991).
6.) SM18-20 denotes Standard Methods for the Examination of Water and Wastewater, 18th, 19th, and 20th Editions, published by the American Public Health Association, Water Environment Federation, and the American Water Works Association.
7.) Other industry-used or agency-approved methods may be used provided that they produce the necessary level of precision and accuracy for data use and reporting.
8.) Updates to the methods listed here are approved for use.
9.) PQL - Practical Quantitation Limit.
10.) MCL - Maximum Contaminant Level from USEPA 2014 Edition of the Drinking Water Standards and Health Advisories. October 2014. http://water.epa.gov/drink/contaminants/index.cfm.
11.) Dash (-) - Indicates no information available.
12.) µg/L - Micrograms per liter.
13.) pCi/L - Picocuries per liter.
14.) NP - Not Promulgated.
15.) mg/L - Milligrams per liter.

Prepared By: JS
Checked By: JSI
Reviewed By: MNH

FIGURES



LEGEND

- Meramec Energy Center Property Boundary
- Active Surface Impoundment
- Exempt Surface Impoundment

KEY MAP

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. SI - SURFACE IMPOUNDMENT.
3. EXEMPT SURFACE IMPOUNDMENTS ARE EXCLUDED FROM COAL COMBUSTION RESIDUALS MONITORING.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 2,000 2,500
Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
SITE LOCATION TOPOGRAPHIC MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	12-10-2015
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0004	1.0	1

AMEREN_00000638

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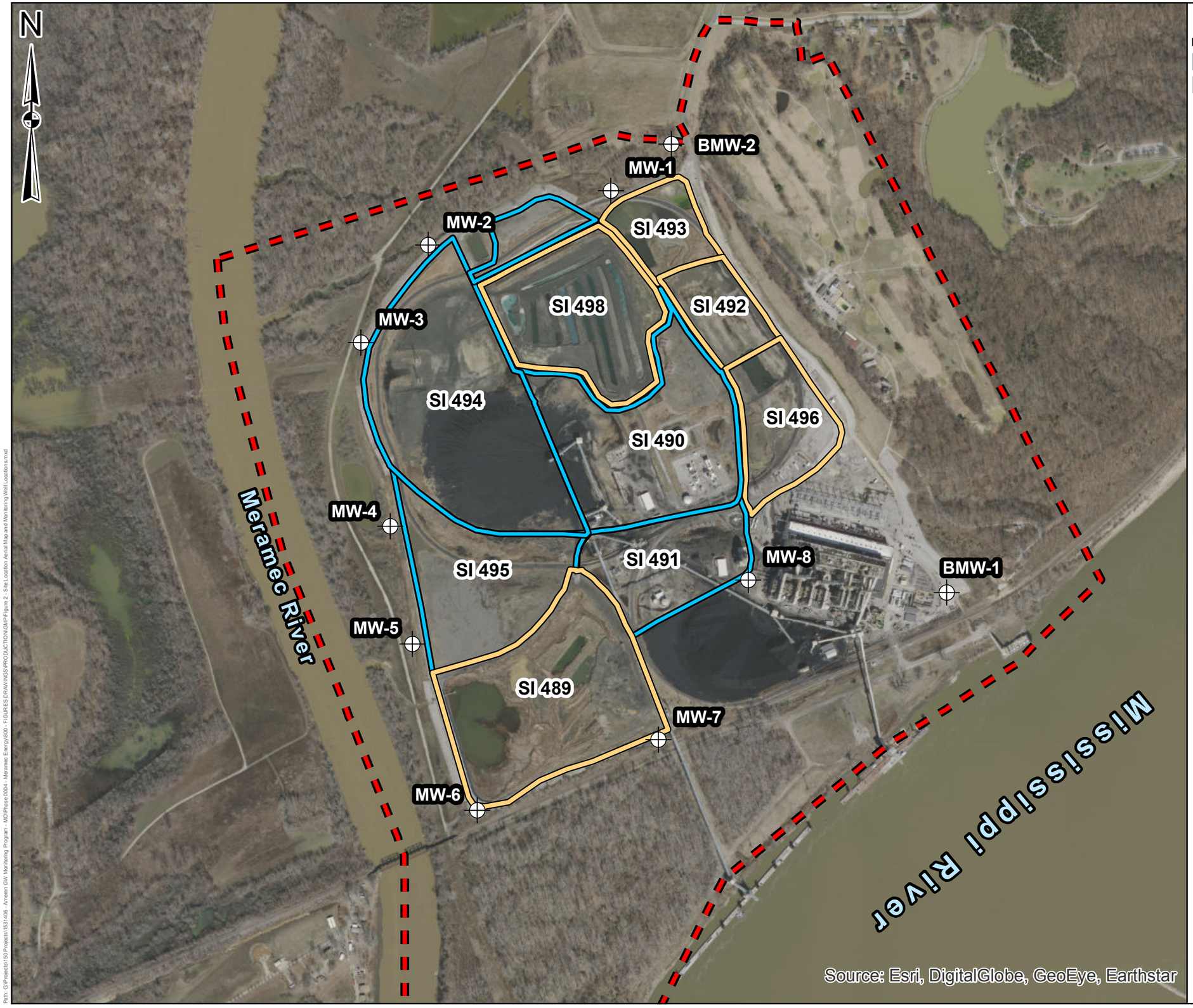
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:



LEGEND

- Meramec Energy Center Property Boundary
- Active Surface Impoundment
- Exempt Surface Impoundment
- Monitoring Well Location

KEY MAP

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. SI - SURFACE IMPOUNDMENT.
3. EXEMPT SURFACE IMPOUNDMENTS ARE EXCLUDED FROM COAL COMBUSTION RESIDUALS MONITORING.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
SITE LOCATION AERIAL MAP AND MONITORING WELL LOCATIONS

CONSULTANT
Golder Associates

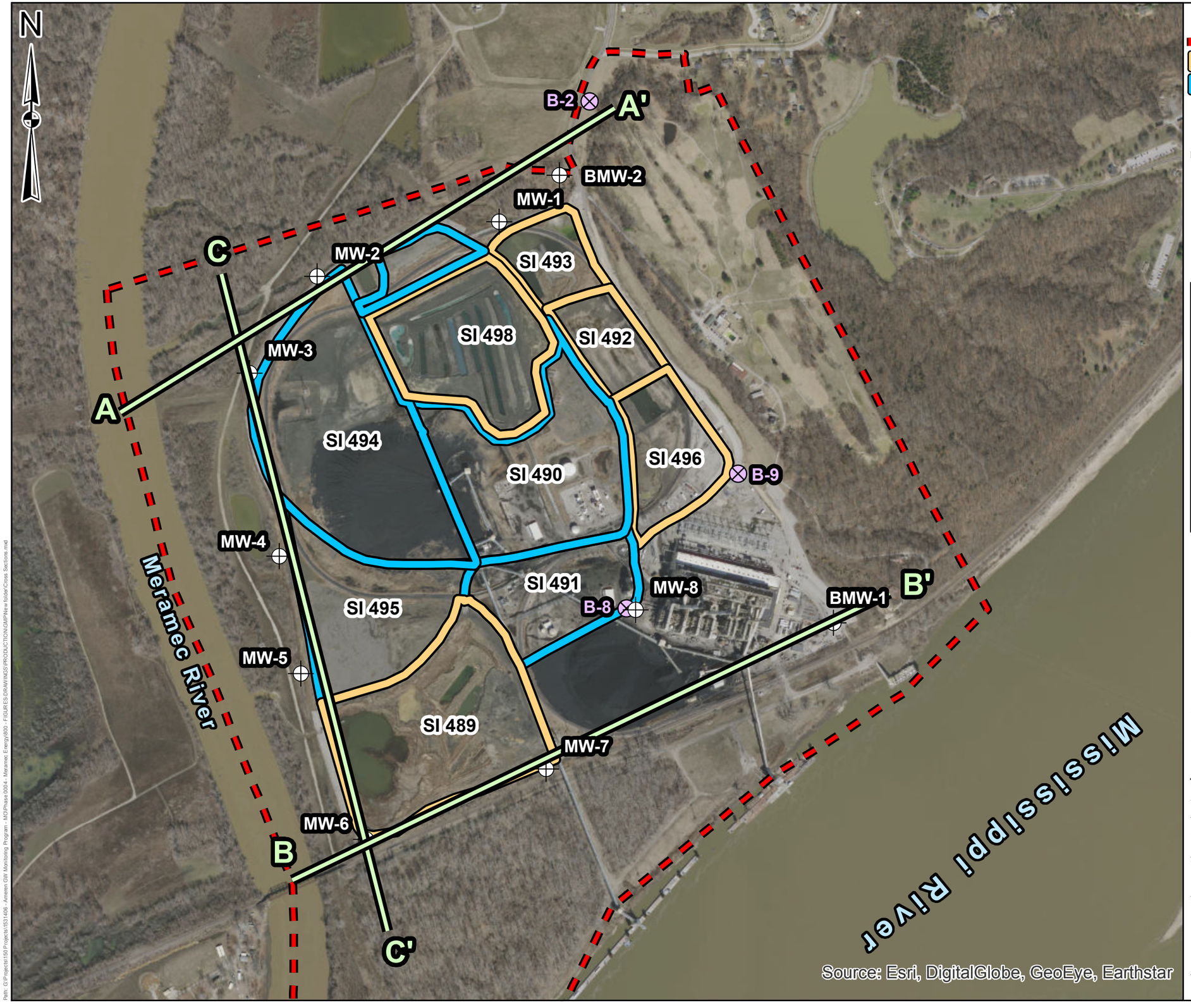
YYYY-MM-DD	2016-03-18
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0004A	1.0	2

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

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP\Figure 2 - Site Location Aerial Map and Monitoring Well Locations.mxd

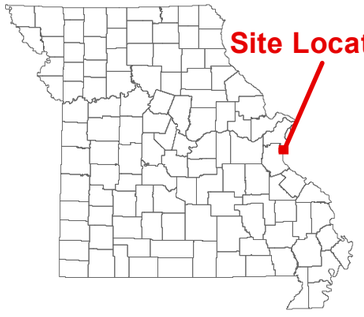
APPENDIX A
CROSS SECTIONS



LEGEND

- Meramec Energy Center Property Boundary
- Active Surface Impoundment
- Exempt Surface Impoundment
- Monitoring Well Location
- Site Investigation Boring Location
- Cross Section Line

KEY MAP



NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. SI - SURFACE IMPOUNDMENT.
3. EXEMPT SURFACE IMPOUNDMENTS ARE EXCLUDED FROM COAL COMBUSTION RESIDUALS MONITORING.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
CROSS SECTION LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-21
PREPARED	JS
DESIGN	JS
REVIEW	JSI
APPROVED	MNH

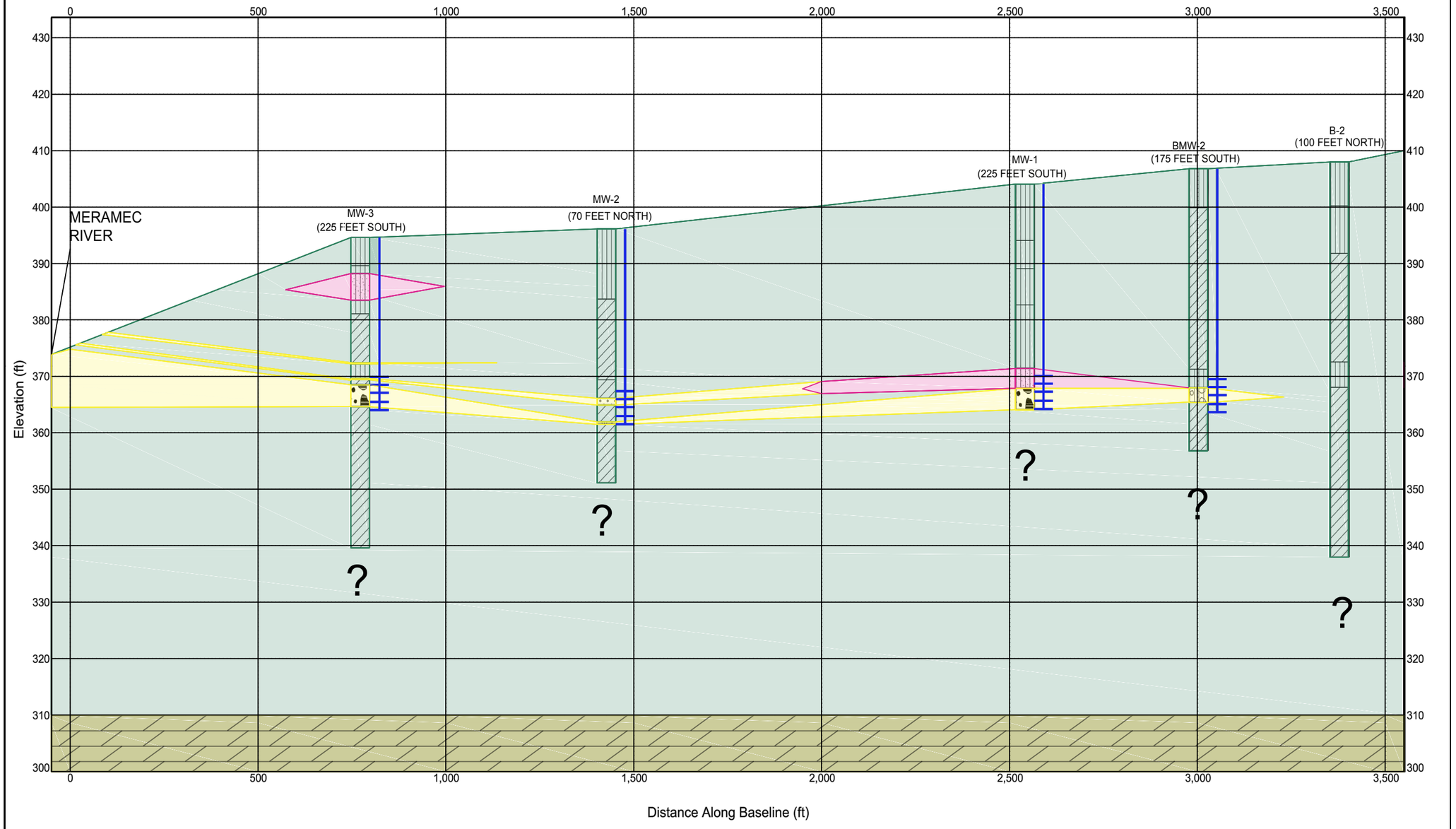
PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0004A	0.0	**A1**

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

Path: G:\Projects\150 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP\New folder\Cross Sections.mxd

A

A'



WEST

EAST

LEGEND

- SILTY SANDS
- SANDS AND GRAVELS
- SILTY CLAYS & SILTS
- BEDROCK
- MONITORING WELL
- SCREENING INTERVAL

NOTE(S)

1. SEE APPENDIX D OF THE GMP FOR SOIL BORING LOGS.
2. SEE APPENDIX E OF THE GMP FOR MONITORING WELL CONSTRUCTION DETAILS.
3. BOREHOLES SHOWN ARE PROJECTED ONTO CROSS SECTION.
4. VERTICAL EXAGGERATION: 15:1.
5. ELEVATION IN FEET ABOVE MEAN SEA LEVEL.
6. BEDROCK ELEVATIONS BASED ON B-8, B-9 AND SHANNON AND WILSON, 1979.
7. FT - FEET

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER
ST. LOUIS COUNTY, MISSOURI

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-21
DESIGNED	JS
PREPARED	JS
REVIEWED	JAP
APPROVED	MNH

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
CROSS SECTION A TO A'

PROJECT NO.	PHASE	REV.	FIGURE
153-1406	0004A	0.0	A2

AMEREN_00000642

Path: \\altlouis\common\Projects\150 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\900 - FIGURES-DRAWINGS\PRO\DJCTIONX-Sections\ | File Name: MEC - Cross Sections.dwg

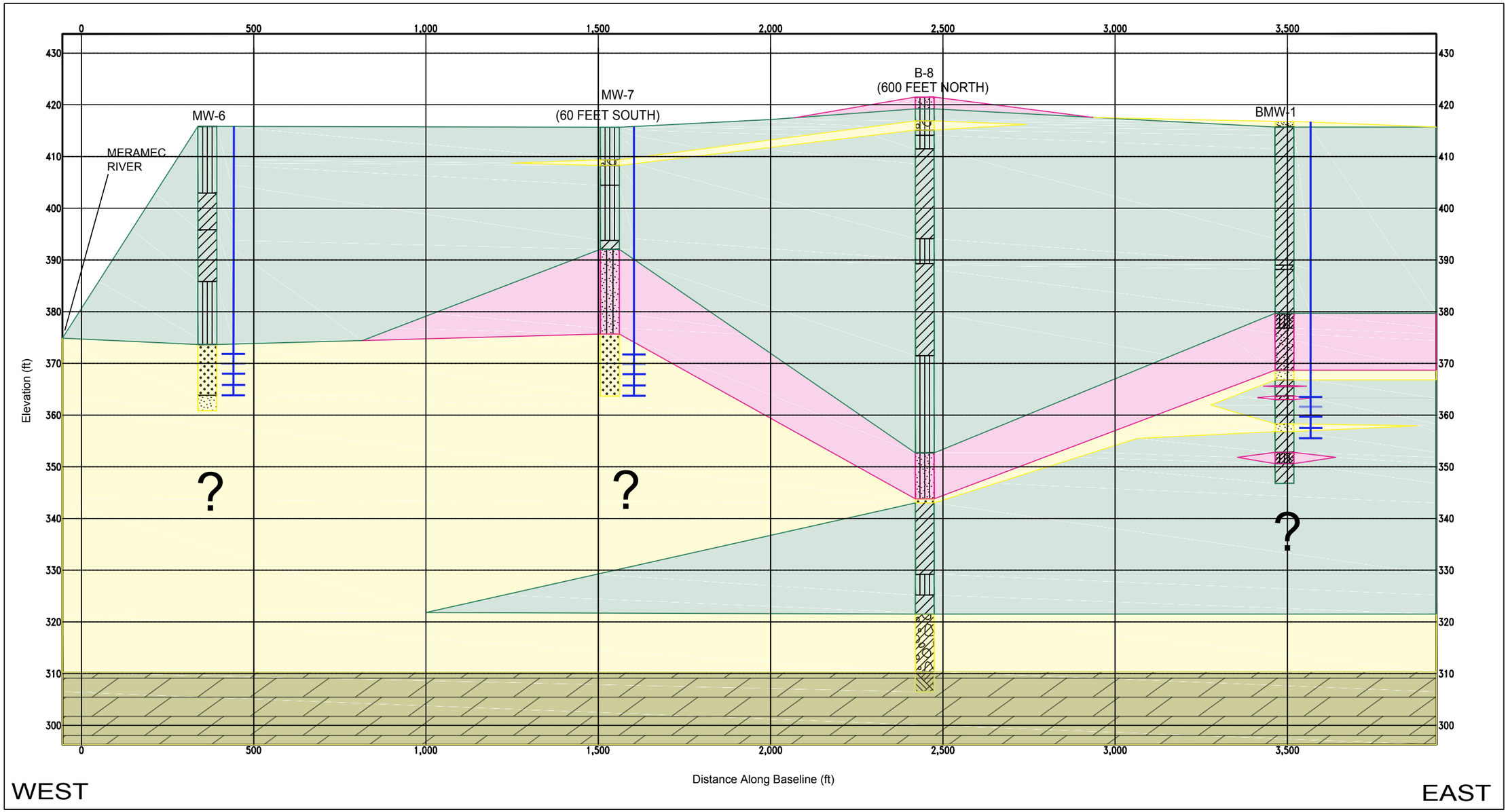
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in

0

B

B'



LEGEND

- SILTY SANDS
- SANDS AND GRAVELS
- SILTY CLAYS & SILTS
- BEDROCK
- MONITORING WELL
- SCREENING INTERVAL

NOTE(S)

1. SEE APPENDIX D OF THE GMP FOR SOIL BORING LOGS.
2. SEE APPENDIX E OF THE GMP FOR MONITORING WELL CONSTRUCTION DETAILS.
3. BOREHOLES SHOWN ARE PROJECTED ONTO CROSS SECTION.
4. VERTICAL EXAGGERATION: 15:1.
5. ELEVATION IN FEET ABOVE MEAN SEA LEVEL.
6. FT - FEET

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER
ST. LOUIS COUNTY, MISSOURI

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-21
DESIGNED	JS
PREPARED	JS
REVIEWED	JAP
APPROVED	MNH

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
CROSS SECTION B TO B'

PROJECT NO.	PHASE	REV.	FIGURE
153-1406	0004A	0.0	A3

AMEREN_00000643

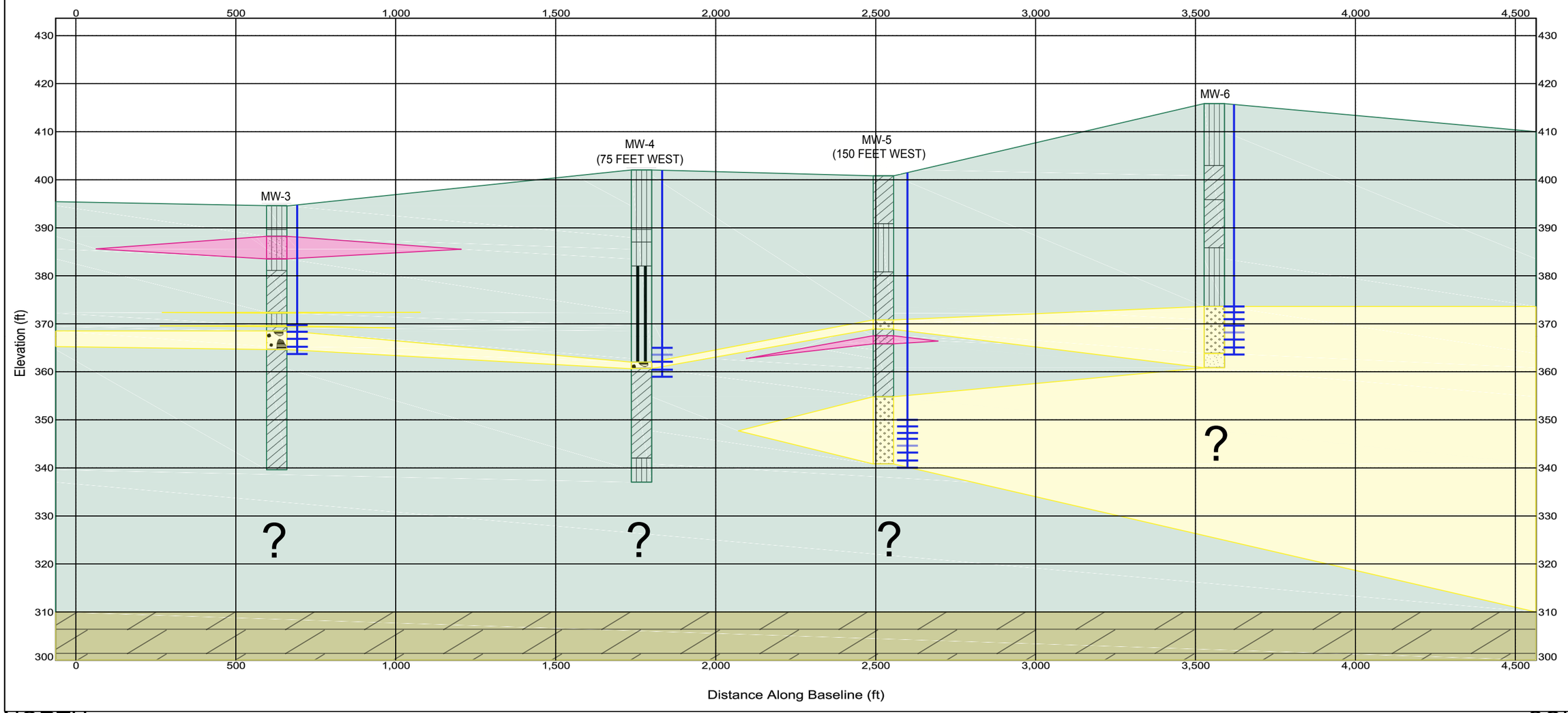
Path: \\altlouis\common\Projects\153 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\800- FIGURES-DRAWINGS\PRODUCTION\X-Sections\ | File Name: MEC - Cross Sections.dwg

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

1 in
0

C

C'



NORTH

SOUTH

LEGEND

- SILTY SANDS
- SANDS AND GRAVELS
- SILTY CLAYS & SILTS
- BEDROCK
- MONITORING WELL
- SCREENING INTERVAL

NOTE(S)

1. SEE APPENDIX D OF THE GMP FOR SOIL BORING LOGS.
2. SEE APPENDIX E OF THE GMP FOR MONITORING WELL CONSTRUCTION DETAILS.
3. BOREHOLES SHOWN ARE PROJECTED ONTO CROSS SECTION.
4. VERTICAL EXAGGERATION: 15:1.
5. ELEVATION IN FEET ABOVE MEAN SEA LEVEL.
6. BEDROCK ELEVATION BASED ON B-8, B-9, AND SHANNON AND WILSON, 1979.
7. FT - FEET

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER
ST. LOUIS COUNTY, MISSOURI

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-21
DESIGNED	JS
PREPARED	JS
REVIEWED	JAP
APPROVED	MNH

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
CROSS SECTION C TO C'

PROJECT NO.	PHASE	REV.	FIGURE
153-1406	0004A	0.0	A4

AMEREN_00000644

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

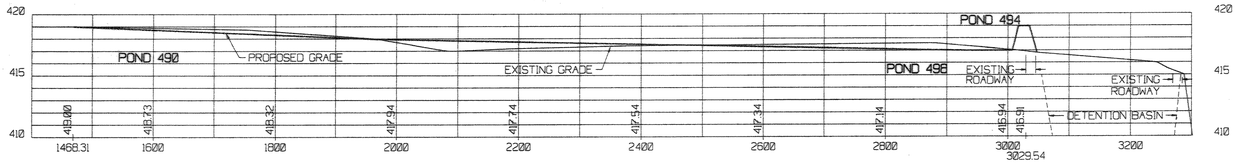
APPENDIX B
EXISTING AMEREN SURFACE IMPOUNDMENT DRAWINGS

PRINT DIST. 9/15/94

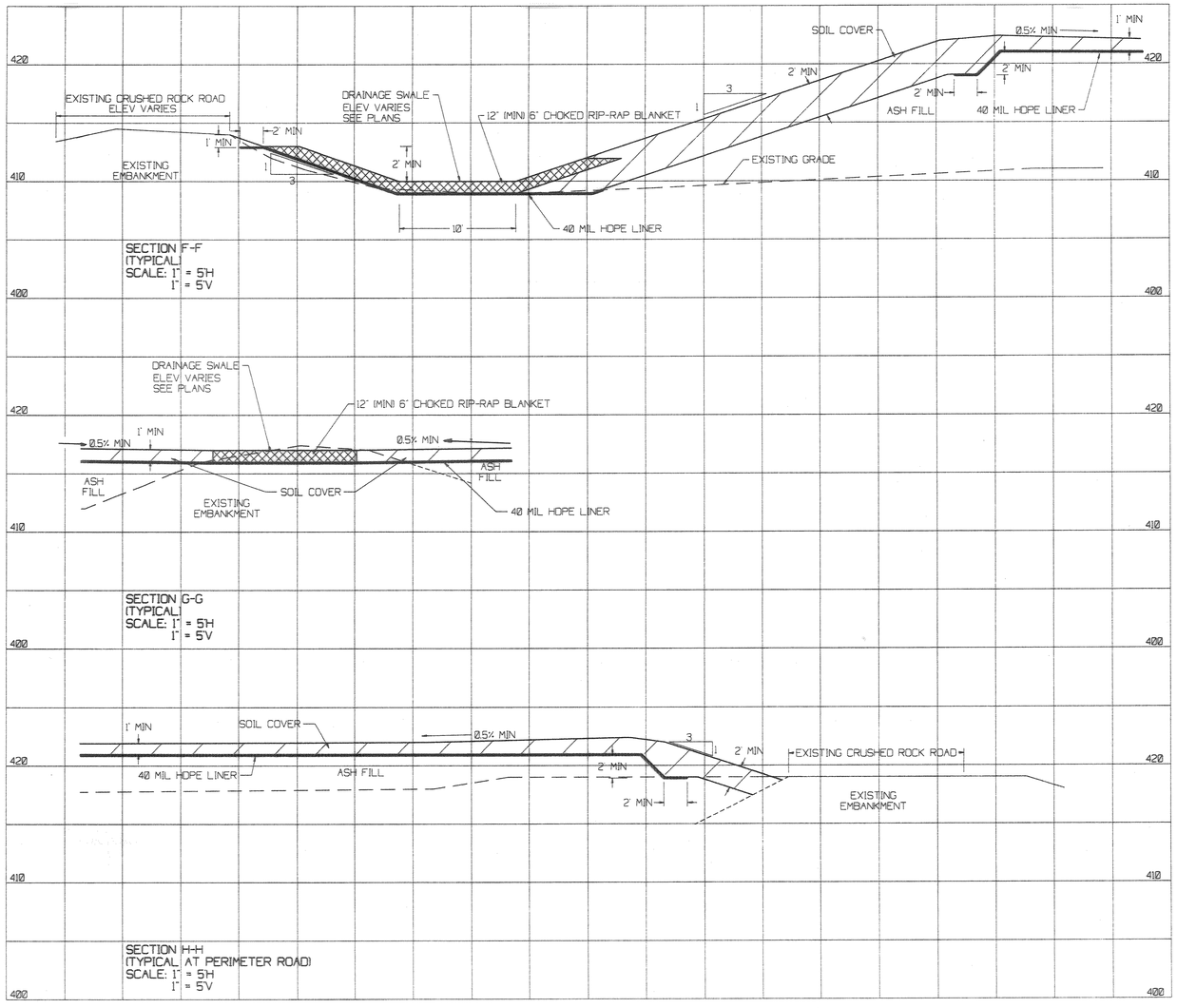
REVISIONS

REV.	W.O.
5	

8020-X-135358



SECTION E-E (ROAD PROFILE)
SCALE 1" = 100H
1" = 5V



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THE RESPONSIBILITY OF THE UNDERSIGNED ENGINEER IS LIMITED TO THE DESIGN WORK SHOWN ON PROJECT DRAWINGS AND DOCUMENTS BEARING HIS (AND) SEAL, SIGNATURE OR INITIALS. HE/SHE DOES NOT ASSUME RESPONSIBILITY FOR ANY CHANGES MADE TO SUCH DOCUMENTS INCLUDING ANY RESPONSIBILITY FOR WORK DONE UNDER SUBSEQUENT REVISIONS AND ANY OTHER DOCUMENTS ASSOCIATED WITH THE PROJECT WHICH DO NOT BEAR HIS/HER SEAL, SIGNATURE OR INITIALS.

SEPTEMBER 14, 1994

STATE OF MISSOURI — PAUL HENRY ASTA — NUMBER E-22033 — REGISTERED PROFESSIONAL ENGINEER

DRAWN	MRF
CHKD.	PHR
SUPV.	
APPD.	

FLYASH POND 489 RECLAMATION

LOCATION		CLASS
001005	MERAMEC POWER PLANT	02010

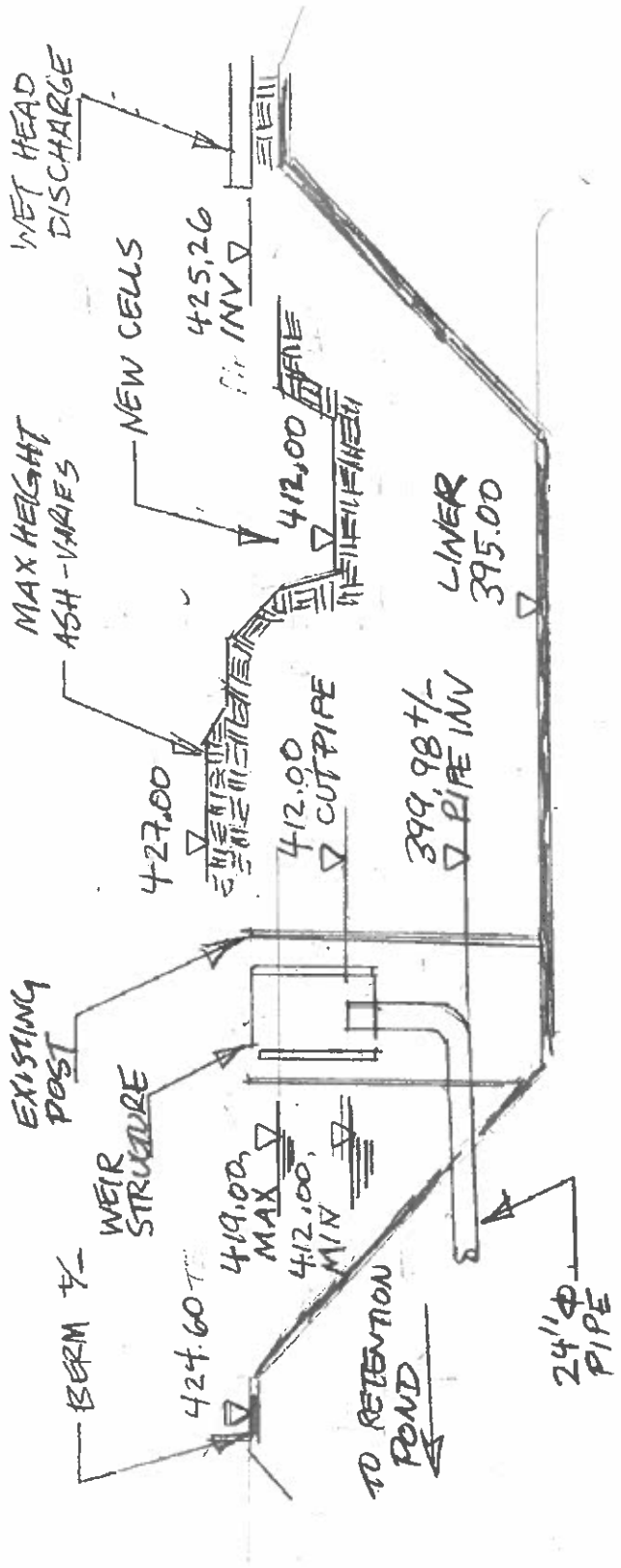
UNION ELECTRIC COMPANY
ST. LOUIS, MO.

8020-X-135358

REV. 0

SHEET 3 OF 3

AMEREN_00000646



MR-DWG-FPD-000006-002

00	21-Oct-11	Release for AMS review	Meramec Power Station 8200 Fine Road St. Louis, Missouri 63129	AMS Ash Management Services	Ash Pond No. 498 Hydraulic profile
01	21-Oct-11	Release for Ameren review			
02	07-Nov-11	Revised			SK-005-R2

APPENDIX C
HISTORICAL HYDROGEOLOGICAL AND RIVER LEVEL INFORMATION

Excerpts From
Woodward-Clyde Consultants, 1988

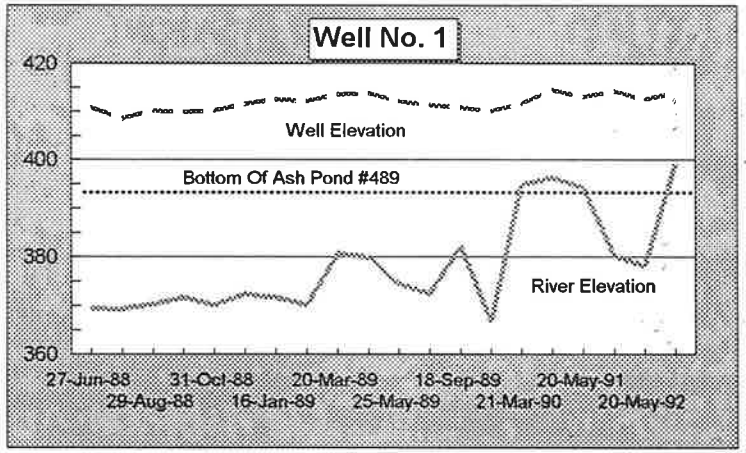
TABLE 1
WATER LEVEL ELEVATIONS (FT MSL)

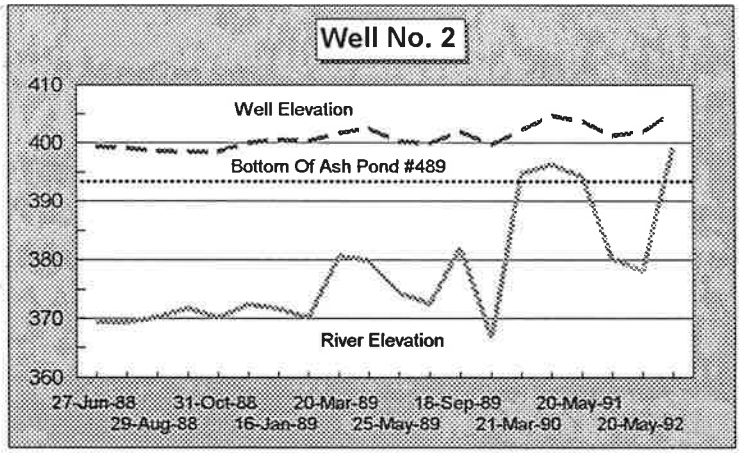
Date (1988)	Boring B-1	Boring B-2	Boring B-3	Boring B-4	Boring B-5	Boring B-6	Boring B-7	Mississippi River Level
1/11	413.3 (ATD)							376.7
1/12								376.9
1/13								377.2
1/14			376.5 (ATD)					376.9
1/15								377.1
1/16								376.1
1/17								375.9
1/18				381.7 (ATD)				376.5
1/19					390.1 (ATD)			377.1
1/20					377.1			379.3
1/21					381.1			382.2
1/22				380.7		390.3 (ATD)	DRY (ATD)	381.9
1/23								382.9
1/24								382.5
1/25								381.4
1/26								380.7
1/27								379.2
1/28			379.8	380.2	380.5	379.3	DRY	379.4
1/29								379.4
1/30								379.8
1/31	412.8	403.5	379.4	379.7	379.8	379.8	DRY	379.7
2/1								381.8

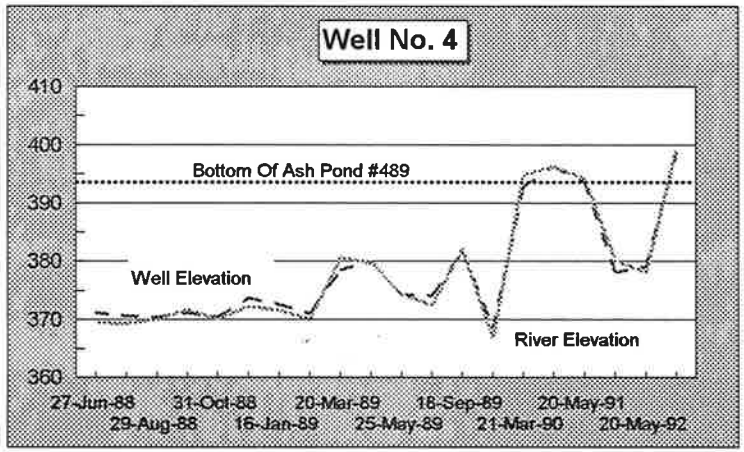
TABLE 1 (continued)
WATER LEVEL ELEVATIONS (FT MSL)

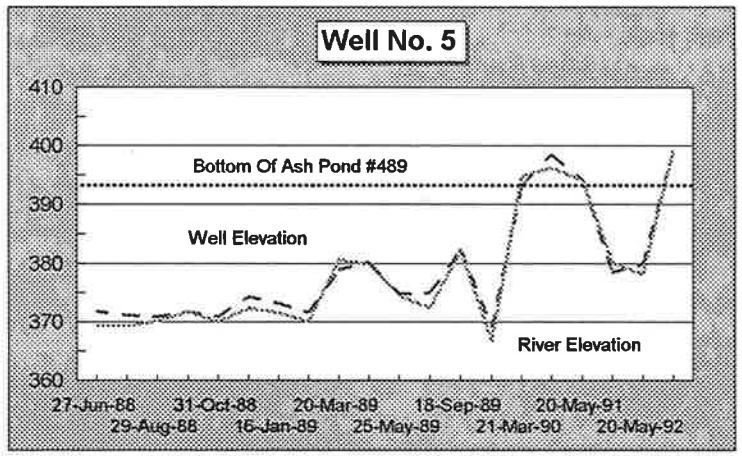
Date (1988)	Boring B-1	Boring B-2	Boring B-3	Boring B-4	Boring B-5	Boring B-6	Boring B-7	Mississippi River Level
2/2								385.3
2/3								385.3
2/4								384.7
2/5	414.8	404.3	385.1	385.0	384.9	384.8	DRY	383.7
2/6								382.7
2/7								380.6
2/8								379.8
2/9	413.9			380.7	380.6	380.6	DRY	380.2
2/10								379.0
2/11								379.3
2/12								378.7
2/13								377.9
2/14								378.0
2/15								378.4
2/16								377.7
2/17	413.4	403.7		379.2	379.1	379.1	DRY	377.8

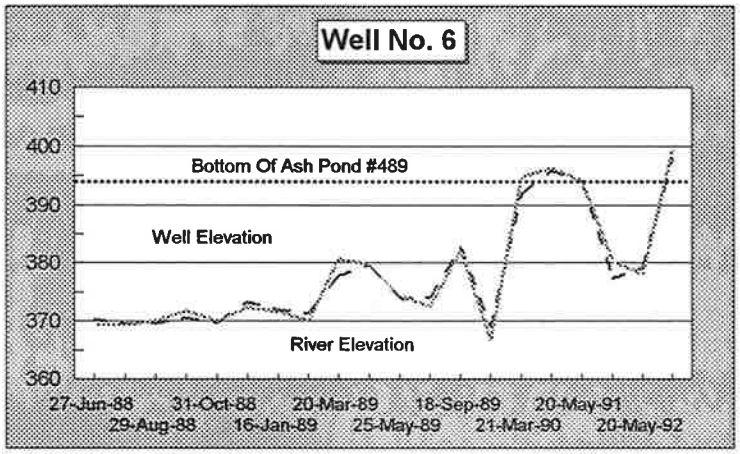
NOTES: 1. ATD = at time of drilling
2. Mississippi River elevation for site is approximate; value was calculated by linear interpolation between measured reiver levels at Jefferson Barracks, which is approximately 7.2 miles upstream from the site; and Waters Point which is approximately 3.0 river miles downstream from the site (U.S. Army Corps of Engineers data). There was generally about a four to five foot difference in elevation between the river level at Jefferson Barracks and the river level at Waters Point.


Well No. 1
420
400
380
360
Well Elevation
Bottom Of Ash Pond #489
River Elevation
27-Jun-88
29-Aug-88
31-Oct-88
16-Jan-89
20-Mar-89
25-May-89
18-Sep-89
21-Mar-90
20-May-91
20-May-92


Well No. 2
410
400
390
380
370
360
Well Elevation
Bottom Of Ash Pond #489
River Elevation
27-Jun-88
29-Aug-88
31-Oct-88
16-Jan-89
20-Mar-89
25-May-89
18-Sep-89
21-Mar-90
20-May-91
20-May-92

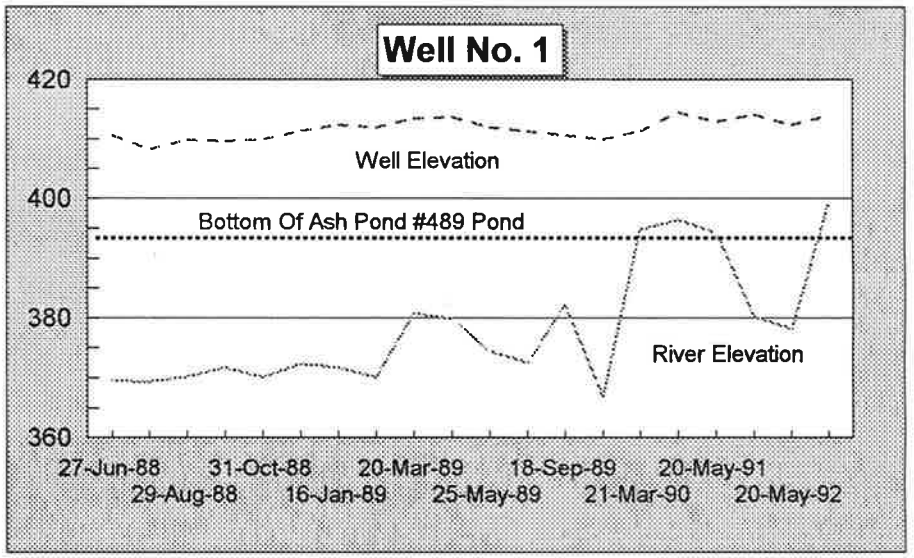

Well No. 4
410
400
390
380
370
360
Bottom Of Ash Pond #489
Well Elevation
River Elevation
27-Jun-88
29-Aug-88
31-Oct-88
16-Jan-89
20-Mar-89
25-May-89
18-Sep-89
21-Mar-90
20-May-91
20-May-92


Well No. 5
410
400
390
380
370
360
Bottom Of Ash Pond #489
Well Elevation
River Elevation
27-Jun-88
29-Aug-88
31-Oct-88
16-Jan-89
20-Mar-89
25-May-89
18-Sep-89
21-Mar-90
20-May-91
20-May-92


Well No. 6
410
400
390
380
370
360
Bottom Of Ash Pond #489
Well Elevation
River Elevation
27-Jun-88
29-Aug-88
31-Oct-88
16-Jan-89
20-Mar-89
25-May-89
18-Sep-89
21-Mar-90
20-May-91
20-May-92

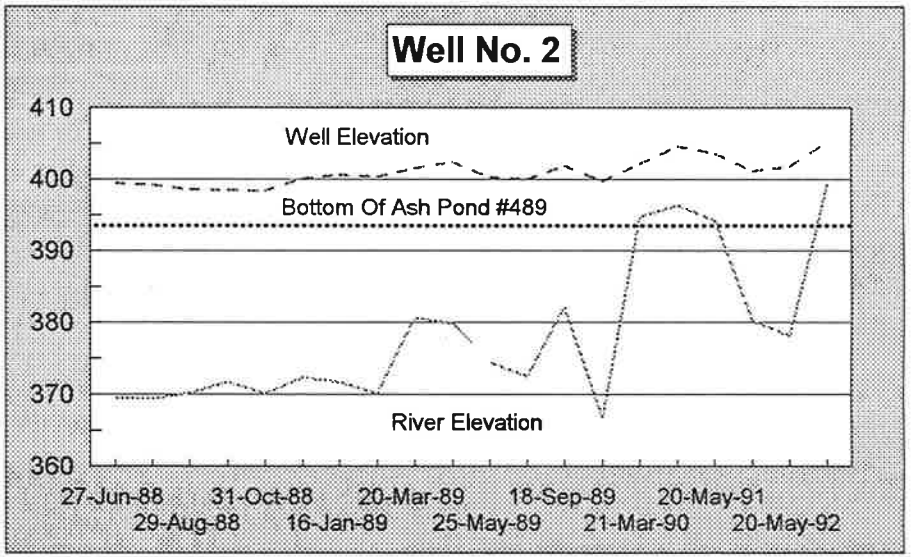
MERAMEC PLANT QUARTERLY
GROUND WATER MONITORING DATA

Date	Time	Well Number	Well Water Level	River Water Level
27-Jun-88	1110	1	410.63	369.48
25-Jul-88	1100	1	408.31	369.36
29-Aug-88	1125	1	409.92	370.18
26-Sep-88	1055	1	409.69	371.74
31-Oct-88	950	1	409.96	370.14
05-Dec-88	920	1	411.39	372.38
16-Jan-89	925	1	412.37	371.68
13-Feb-89	930	1	411.96	370.08
20-Mar-89	820	1	413.46	380.68
17-Apr-89	1030	1	413.63	379.85
25-May-89	1230	1	411.89	374.43
26-Jun-89	1030	1	411.22	372.53
18-Sep-89	1042	1	410.57	382.13
12-Dec-89	1000	1	410.03	366.74
21-Mar-90	1008	1	411.39	394.78
13-Jun-90	1022	1	414.34	396.33
20-May-91	1007	1	412.84	394.18
21-Nov-91	857	1	414.06	380.23
20-May-92	840	1	412.36	378.15
14-Jun-93	853	1	413.87	399.28



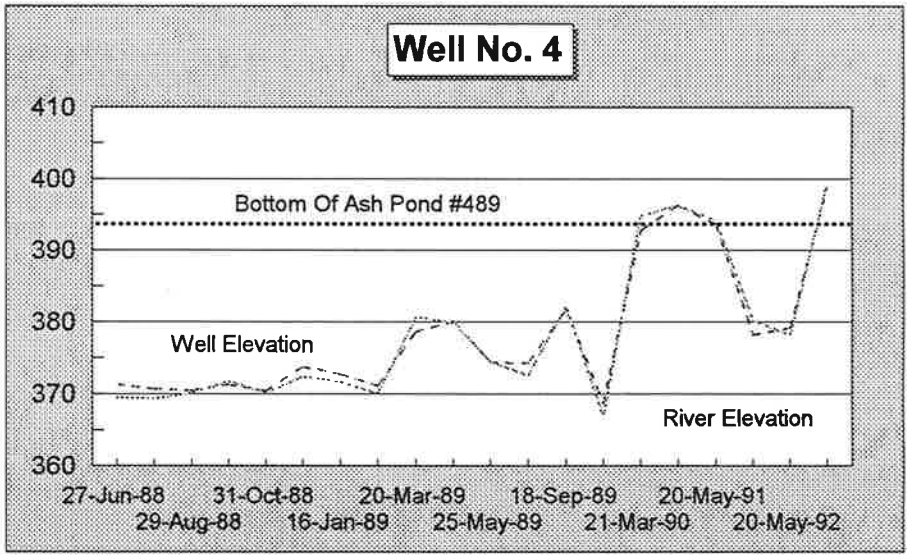
MERAMEC PLANT QUARTERLY
GROUND WATER MONITORING DATA

Date	Time	Well Number	Well Water Level	River Water Level
27-Jun-88	1350	2	399.43	369.48
25-Jul-88	1310	2	399.16	369.36
29-Aug-88	1305	2	398.55	370.18
26-Sep-88	1310	2	398.53	371.74
31-Oct-88	1040	2	398.44	370.14
05-Dec-88	1100	2	400.08	372.38
16-Jan-89	1040	2	400.59	371.68
13-Feb-89	1015	2	400.37	370.08
20-Mar-89	915	2	401.54	380.68
17-Apr-89	1220	2	402.41	379.85
25-May-89	1300	2	400.30	374.43
26-Jun-89	1115	2	399.97	372.53
18-Sep-89	1110	2	401.90	382.13
12-Dec-89	1036	2	399.71	366.74
21-Mar-90	1040	2	402.17	394.78
13-Jun-90	1050	2	404.58	396.33
20-May-91	1041	2	403.60	394.18
21-Nov-91	1022	2	401.12	380.23
20-May-92	940	2	401.78	378.15
14-Jun-93	927	2	405.22	399.28



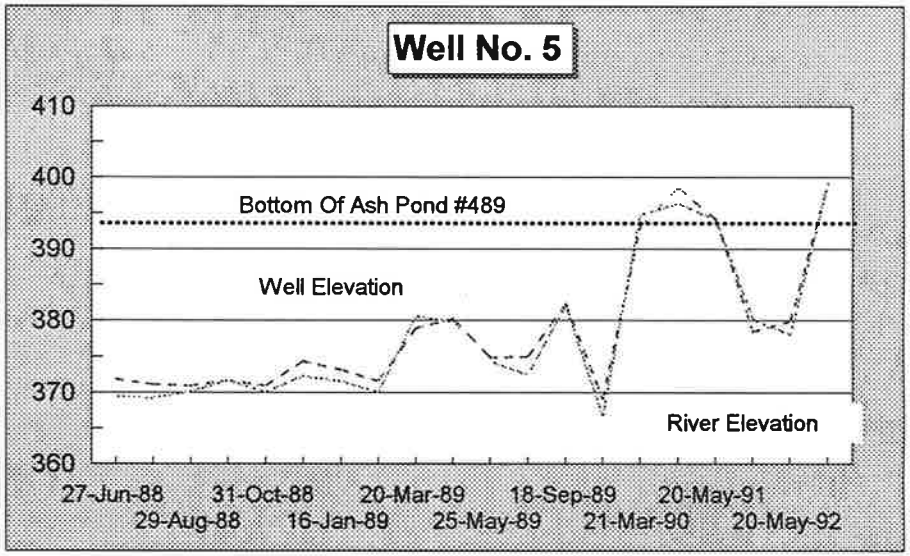
MERAMEC PLANT QUARTERLY
GROUND WATER MONITORING DATA

Date	Time	Well Number	Well Water Level	River Water Level
27-Jun-88	1500	4	371.28	369.48
25-Jul-88	1505	4	370.67	369.36
29-Aug-88	1455	4	370.48	370.18
26-Sep-88	1440	4	371.28	371.74
31-Oct-88	1305	4	370.46	370.14
05-Dec-88	1300	4	373.73	372.38
16-Jan-89	1330	4	372.66	371.68
13-Feb-89	1230	4	371.14	370.08
20-Mar-89	1215	4	378.63	380.68
17-Apr-89	1305	4	380.08	379.85
25-May-89	1400	4	374.37	374.43
26-Jun-89	1300	4	374.22	372.53
18-Sep-89	1304	4	381.73	382.13
12-Dec-89	1214	4	368.62	366.74
21-Mar-90	1120	4	392.72	394.78
13-Jun-90	1244	4	396.28	396.33
20-May-91	1242	4	393.61	394.18
21-Nov-91	1317	4	378.22	380.23
20-May-92	1243	4	379.17	378.15
14-Jun-93	1007	4	398.67	399.28



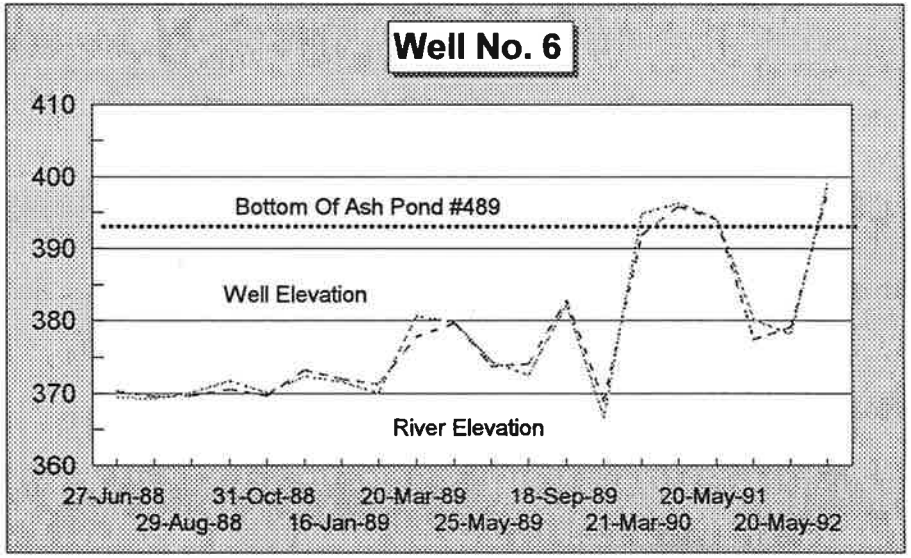
MERAMEC PLANT QUARTERLY
GROUND WATER MONITORING DATA

Date	Time	Well Number	Well Water Level	River Water Level
27-Jun-88	1610	5	371.89	369.48
25-Jul-88	1550	5	371.16	369.36
29-Aug-88	1550	5	370.99	370.18
26-Sep-88	1605	5	371.78	371.74
31-Oct-88	1350	5	370.98	370.14
05-Dec-88	1320	5	374.41	372.38
16-Jan-89	1415	5	373.25	371.68
13-Feb-89	1415	5	371.68	370.08
20-Mar-89	1305	5	378.98	380.68
17-Apr-89	1545	5	380.26	379.85
25-May-89	1430	5	374.96	374.43
26-Jun-89	1340	5	375.06	372.53
18-Sep-89	1334	5	382.33	382.13
12-Dec-89	1253	5	369.12	366.74
21-Mar-90	1143	5	393.14	394.78
13-Jun-90	1305	5	398.52	396.33
20-May-91	1317	5	394.24	394.18
21-Nov-91	1354	5	378.55	380.23
20-May-92	1336	5	379.91	378.15
14-Jun-93	1035	5	399.21	399.28



MERAMEC PLANT QUARTERLY
GROUND WATER MONITORING DATA

Date	Time	Well Number	Well Water Level	River Water Level
27-Jun-88	1705	6	370.38	369.48
25-Jul-88	1705	6	369.62	369.36
29-Aug-88	1705	6	369.73	370.18
26-Sep-88	1705	6	370.61	371.74
31-Oct-88	1515	6	369.75	370.14
05-Dec-88	1400	6	373.29	372.38
16-Jan-89	1600	6	371.99	371.68
13-Feb-89	1505	6	371.36	370.08
20-Mar-89	1400	6	377.84	380.68
17-Apr-89	1625	6	379.70	379.85
25-May-89	1600	6	373.84	374.43
26-Jun-89	1500	6	374.07	372.53
18-Sep-89	1356	6	382.77	382.13
12-Dec-89	1323	6	368.92	366.74
21-Mar-90	1208	6	391.89	394.78
13-Jun-90	1326	6	395.88	396.33
20-May-91	1338	6	394.14	394.18
21-Nov-91	1336	6	377.41	380.23
20-May-92	1045	6	379.12	378.15
14-Jun-93	1107	6	398.06	399.28



Excerpt From
CH2MHILL, 1997

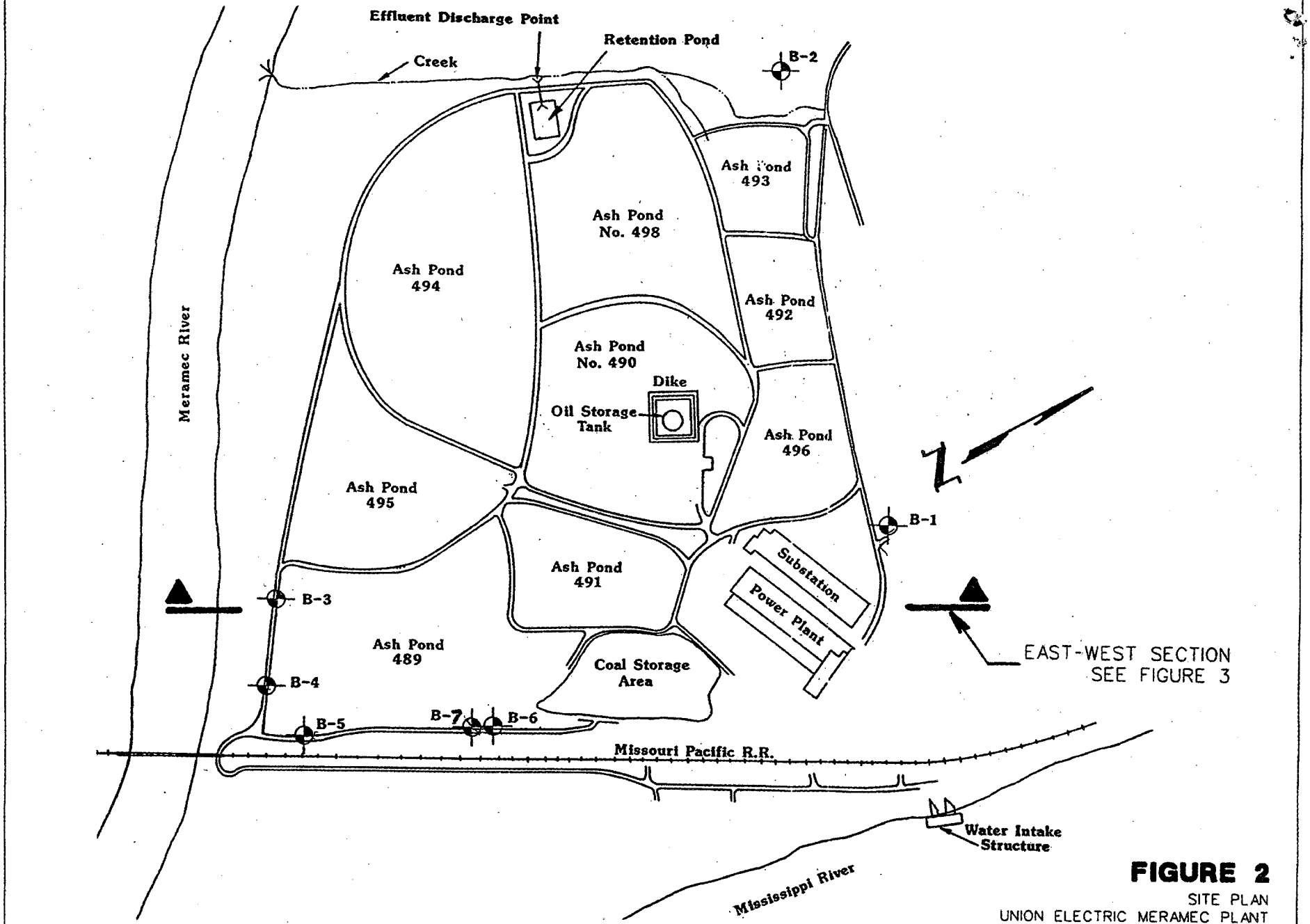


FIGURE 2

SITE PLAN
UNION ELECTRIC MERAMEC PLANT
ST. LOUIS COUNTY, MISSOURI

CH2MHILL

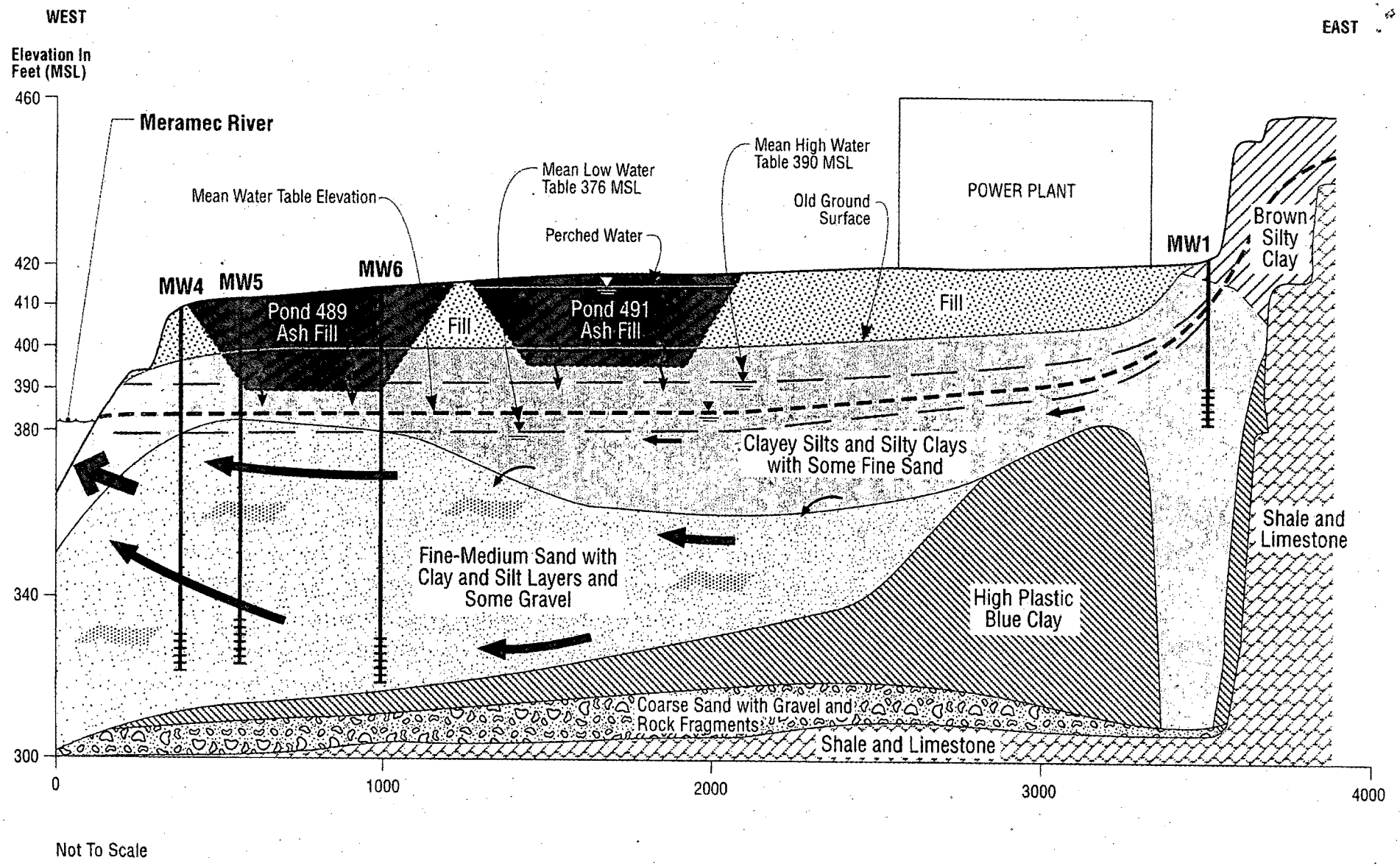
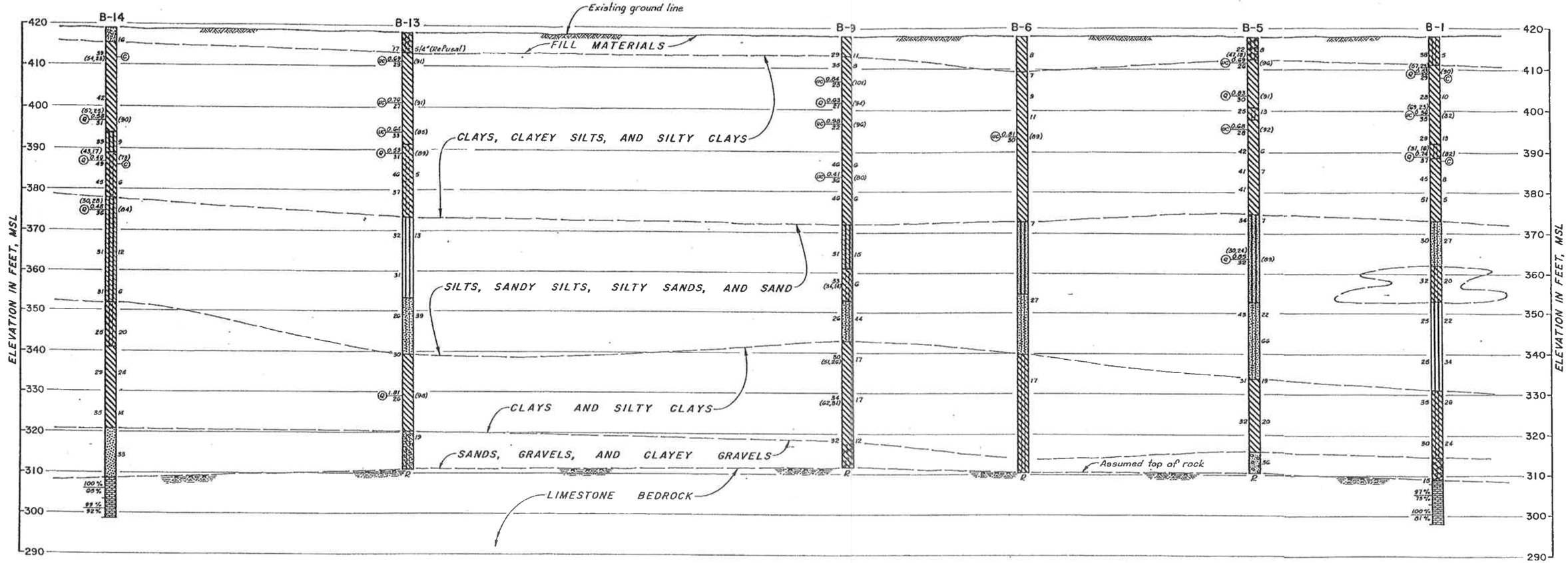


FIGURE 3
Conceptual Site Model
Union Electric Meramec Plant, St. Louis County, MO

E143874.SR.ZZ Cross-Section 12-3-97 mjl

CH2MHILL

Excerpt From
Shannon & Wilson, Inc., 1979



SECTION A-A

20 15 10 5 0 20 40 60
SCALE IN FEET

NOTES:
1. See Plate 2 for location of section.
2. See Plate 5 for legend.

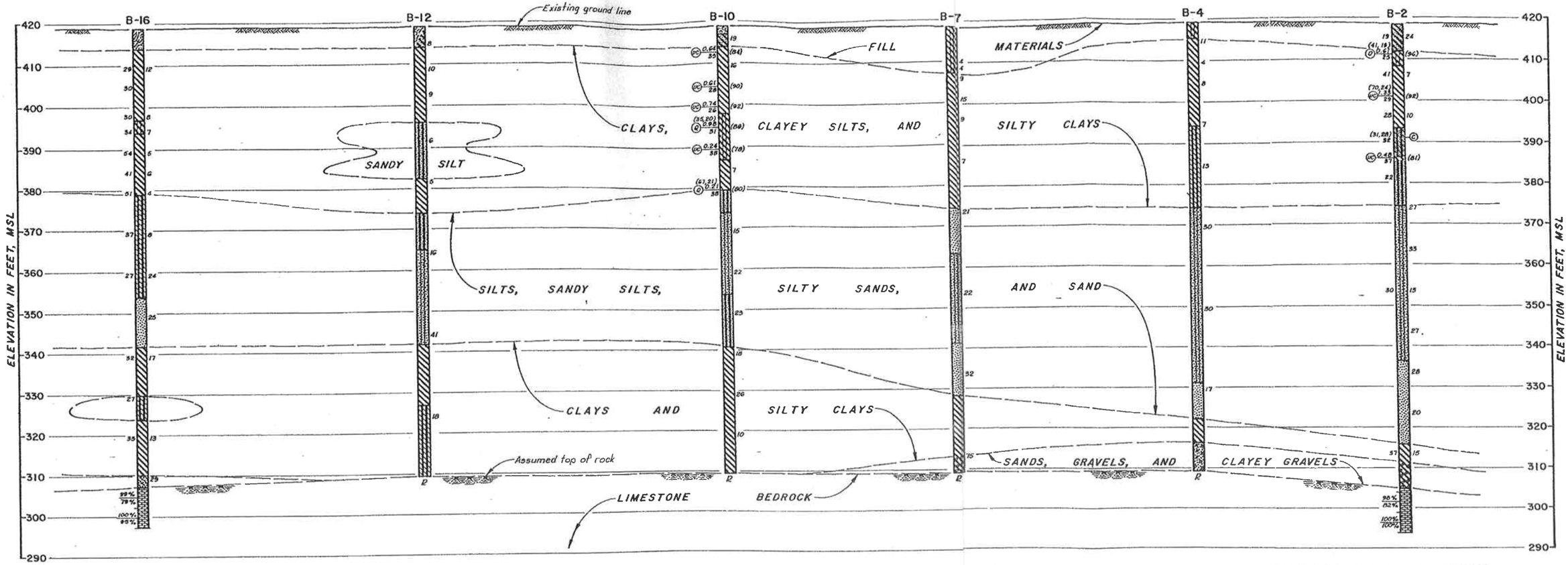
General Note:
Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions at locations between borings may differ from the generalized profile shown here.

GENERALIZED SOIL AND ROCK PROFILE
ALONG SECTION A-A

SHANNON & WILSON, INC.
GEOTECHNICAL CONSULTANTS

M-256

PLATE 3



SECTION B-B

20 15 10 5 0 20 40 60
SCALE IN FEET

NOTES:
1. See Plate 2 for location of section.
2. See Plate 5 for legend.

General Note:
Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions at locations between borings may differ from the generalized profile shown here.

GENERALIZED SOIL AND ROCK PROFILE
ALONG SECTION B-B

SHANNON & WILSON, INC.
GEOTECHNICAL CONSULTANTS

PLATE

APPENDIX D
CCR MONITORING WELL BORING LOGS

RECORD OF BOREHOLE BMW-1

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 4/7/2016
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: N/A E: N/A

ELEVATION: 416.79
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0-1.1) CONCRETE			415.9				
		(1.1-27.8) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; greenish black (5GY 2/1); cohesive, w~PL, firm			1.1	1	SO	1.9 / 5.0	
5		(5.0) SAA (Same As Above), medium gray (N5) mottled with moderate yellowish brown (10YR 5/4)			412.0 5.0	2	SO	2.9 / 5.0	
10		(10.0) SAA, stiff			407.0 10.0	3	SO	5.0 / 5.0	
		(13.6) SAA, dark gray (N3)	CL		403.4 13.6				
15		(15.0) SAA, trace organic fragments (wood)			402.0 15.0	4	SO	5.0 / 5.0	
20		(20.0) SAA, some non-plastic fines; firm			397.0 20.0	5	SO	5.0 / 5.0	Run #4, Silty clay in sample appears to be swelling when brought to the surface resulting in recovery over 100%. Measured field recovery: 6.0/5.0. Estimated actual recovery: 5.0/5.0
25		(25.0) SAA, medium gray (N5) mottled with moderate yellowish brown (10YR 5/4)			392.0 25.0	6	SO	5.0 / 5.0	▽ Water Level 25.23 ft bgs 4/11/2016
		(27.8-28.6) (ML) CLAYEY SILT, low plasticity fines, trace fine sand; light brownish gray (5YR 6/1) mottled moderate yellowish brown (10YR 5/4); cohesive, w<PL, soft	ML		389.2 27.8				Run #5, Silty clay in sample appears to be swelling when brought to the surface resulting in recovery over 100%. Measured field recovery: 5.3/5.0. Estimated actual recovery: 5.0/5.0
			CL		388.4 28.6				
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE BMW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 4/7/2016
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: N/A E: N/A

ELEVATION: 416.79
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(28.6-37.1) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5) to light brownish gray (5YR 6/1) mottled with moderate yellowish brown (10YR 5/4); cohesive, w<PL, soft *(Continued)*	CL		379.9				Run #6, Silty clay in sample appears to be swelling when brought to the surface resulting in recovery over 100%. Measured field recovery: 5.7/5.0. Estimated actual recovery: 5.0/5.0
35						7	SO	10.0 / 10.0	
		(37.1-40.0) (ML) sandy CLAYEY SILT, medium plasticity fines, some fine sand; medium gray (N5); cohesive, w<PL, soft	MH		37.1 377.0				
40		(40.0-48.1) (SC) CLAYEY SAND, fine sand, low plasticity fines; medium gray (N5); non-cohesive, wet, loose	SC		40.0 368.9				
45						8	SO	10.0 / 10.0	
		(48.1-50.0) (SP) SAND, fine sand, trace non-plastic fines; brownish gray (5YR 4/1); non-cohesive, wet, loose	SP		48.1 367.0				
50		(50.0-51.1) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium gray (N5); cohesive, w>PL, firm	CL		50.0 365.9				
		(51.1-51.3) (SC) CLAYEY SAND, fine sand, medium plasticity fines; medium gray (N5); cohesive, w<PL, firm	SC		51.1 365.7				
		(51.3-53.1) (CL) SILTY CLAY, medium to high plasticity, trace fine sand; medium gray (N5); cohesive, w<PL, firm	CL		51.3 363.9				
		(53.1-53.8) (SC) CLAYEY SAND, fine sand, medium plasticity fines; medium gray (N5); cohesive, w<PL, firm	SC		53.1 363.2				
		(53.8-58.5) (CL) SILTY CLAY, low to medium plasticity, some fine sand; medium gray (N5); cohesive, w~PL, firm	CL		53.8 358.5				
55						10	SO	9.2 / 10.0	
		(58.5-60.0) (SP) SAND, fine sand, trace non-plastic fines; brownish gray (5YR 4/1); non-cohesive, wet, compact	SP		58.5 357.0				
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE BMW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 4/7/2016
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: N/A E: N/A

ELEVATION: 416.79
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(60.0-64.0) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium gray (N5); cohesive, w~PL, firm	CL		60.0				
					353.0				
65		(64.0-66.2) (ML) sandy CLAYEY SILT, low plasticity fines, fine sand; medium gray (N5); non-cohesive, wet, compact	ML		64.0	9	SO	10.0 / 10.0	
					350.8				
		(66.2-70.0) (CL) SILTY CLAY, medium to high plasticity, trace fine sand; medium gray (N5) to brownish gray (5YR 4/1); cohesive, w>PL, stiff	CL		66.2				
70					347.0				
		END OF BORING AT 70.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG BMW-1.			70.0				
75									
80									
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JSI/JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE BMW-2

SHEET 1 of 2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/25/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,927.10 E: 866,342.24

ELEVATION: 406.80
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-6.9) (ML) CLAYEY SILT, medium plasticity fines, some organics (roots), trace fine sand; dark yellowish brown (10YR 4/2) to dusky yellowish brown (10YR 2/2); cohesive, w~PL, firm	ML			1	SO	4.6 / 5.0	
5						2	SO	3.6 / 5.0	
					399.9 / 6.9				
10		(6.9-35.6) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2); cohesive, w~PL, firm	CL			3	SO	4.9 / 5.0	▽ Water Level 11.89 ft bgs 2/16/2016
		(12.5) SAA (Same As Above) except, stiff			394.3 / 12.5				
15		(15.0) SAA except, firm			391.8 / 15.0	4	SO	5.0 / 5.0	
20		(21.8) SAA except, low plasticity fines; medium dark gray (N4); w<PL			385.0 / 21.8	5	SO	10.0 / 10.0	
25									
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE BMW-2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/25/16
DRILL RIG: Mini Sonic (CDD1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,927.10 E: 866,342.24
ELEVATION: 406.80
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(6.9-35.6) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2); cohesive, w~PL, firm *(Continued)*	CL						
35					371.2	6	SO	10.0 / 10.0	
		(35.6-38.8) (ML) CLAYEY SILT, low plasticity fines, some sub-angular fine to coarse gravel; dark gray (N3); cohesive, w<PL, firm	ML		35.6				
					368.0				
		(38.8-41.4) (GM) SILTY GRAVEL, fine to coarse sub-angular gravel, non-plastic fines, trace fine sand; brownish gray (5YR 4/1); non-cohesive, wet, compact	GM		38.8				
40		(40.0) SAA except, some fine to coarse sub-rounded sand			366.8 / 40.0				
					365.4				
		(41.4-50.0) (CL) SILTY CLAY, high plasticity fines; dark gray (N3); cohesive, w>PL, stiff	CL		41.4	7	SO	7.7 / 10.0	
45									
50					356.8				
		END OF BORING AT 50.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG BMW-2.			50.0				
55									
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-1

SHEET 1 of 2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,676.92 E: 865,954.06

ELEVATION: 404.10
INCLINATION: -90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-10.0) (ML) SILT, non-plastic fines, some fine sand, some organics (roots); dark yellowish brown (10YR 4/2); cohesive, w<PL, soft	ML			1	SO	2.7 / 5.0	▽ Water Level 2.23 ft bgs 2/16/2016
5		(5.0) SAA (Same As Above) except, firm			399.1 / 5.0	2	SO	5.0 / 5.0	
10		(10.0-15.0) (ML) CLAYEY SILT, low to medium plasticity fines, some fine sand; moderate yellowish brown (10YR 5/4) to dark yellowish brown (10YR4/2); cohesive, w~PL, soft to firm	ML		394.1 / 10.0	3	SO	5.0 / 5.0	
15		(15.0-21.4) (ML) SILT, non-plastic fines, trace fine sand; moderate yellowish brown (10YR 5/4); cohesive, w<PL, soft	ML		389.1 / 15.0	4	SO	5.0 / 5.0	
20		(21.4-32.7) (ML) SILT, non-plastic to low plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w<PL, soft	ML		382.7 / 21.4	5	SO	10.0 / 10.0	
25									
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-1

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,676.92 E: 865,954.06

ELEVATION: 404.10
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(21.4-32.7) (ML) SILT, non-plastic to low plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w<PL, soft *(Continued)*	ML		371.4				
		(32.7-36.2) (SM) SILTY SAND, fine to coarse well graded sand, non-plastic to low plasticity fines, trace sub-rounded gravel; brownish gray (5YR 4/1); non-cohesive, wet, compact	SM		32.7 367.9	6	SO	10.0 10.0	
35		(36.2-40.0) (GW) sandy GRAVEL, fine to coarse sub-rounded gravel, fine to coarse sub-rounded sand, some non-plastic to low plasticity fines; brownish gray (5YR 4/1); non-cohesive, wet, compact	GW		36.2 364.1				
40		END OF BORING AT 40.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-1.			40.0				
45									
50									
55									
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,325.09 E: 864,864.51

ELEVATION: 396.13
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-12.4) (ML) SILT, non-plastic fines, trace fine sand, some organics (roots); dark yellowish brown (10YR 4/2); non-cohesive, moist, compact	ML			1	SO	3.2 / 5.0	
5		(5.0) SAA (Same As Above) except, dark yellowish brown (10YR 4/2) to brownish black (5YR 2/1)			391.1 5.0	2	SO	3.6 / 5.0	
10					383.7 12.4	3	SO	4.7 / 5.0	▽ Water Level 12.57 ft bgs 2/16/2016
15		(12.4-26.8) (CL) SILTY CLAY, low to medium plasticity fines, trace fine sand; medium dark gray (N4) mottled dark yellowish brown (10YR 4/2); cohesive, w~PL, stiff (15.0) SAA except, firm to stiff	CL		381.1 15.0	4	SO	8.8 / 10.0	
20									
25		(25.0) SAA except, firm			371.1 25.0	5	SO	10.0 / 10.0	
30		(26.8-30.0) (CL) SILTY CLAY, medium plasticity fines, some fine sand; medium dark gray (N4); cohesive, w~PL, soft Log continued on next page	CL		369.3 26.8 366.1				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 937,325.09 E: 864,864.51

ELEVATION: 396.13
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-31.2) (SW) SAND, fine to coarse sub-rounded sand, trace low plasticity fines; brownish gray (5YR 4/1); non-cohesive, wet, compact	SW		30.0				
					364.9				
		(31.2-34.2) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w~PL, firm	CL		31.2	5	SO	10.0 / 10.0	
					361.9				
		(34.2-34.6) (GM) SILTY GRAVEL, fine to coarse sub-rounded gravel, low plasticity fines, trace fine to coarse sub-rounded sand; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	GM		34.2				
					361.5				
35					34.6				
					361.1				
		(34.6-45.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w~PL, firm (35.0) SAA except, stiff	CL		35.0	6	SO	10.0 / 10.0	
40									
					351.1				
45		END OF BORING AT 45.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-2.			45.0				
50									
55									
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-3

SHEET 1 of 2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/22/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 936,750.84 E: 864,447.17

ELEVATION: 394.63
INCLINATION: -90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-5.0) (ML) SILT, non-plastic to low plasticity fines, some fine sand; dark yellowish brown (10YR 4/2); cohesive, w<PL, firm	ML		389.6	1	SO	2.9 / 5.0	
5		(5.0-6.4) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2) to dusky yellowish brown (10YR 2/2); cohesive, w~PL, firm	ML		5.0 388.2				
		(6.4-11.1) (SM) SILTY SAND, fine poorly graded sand, non-plastic fines; dark gray (N3); non-cohesive, wet, compact	SM		6.4	2	SO	4.2 / 5.0	
10					383.5				▽ Water Level 11.07 ft bgs 2/16/2016
		(11.1-13.5) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; brownish black (5YR 2/1); cohesive, w<PL, firm	ML		11.1 381.1	3	SO	4.9 / 5.0	
		(13.5-22.2) (CL) SILTY CLAY, medium to high plasticity fines; dark yellowish brown (10YR 4/2); cohesive, w>PL, stiff	CL		13.5 379.6				
15		(15.0) SAA (Same As Above) except, w~PL, firm			15.0	4	SO	5.0 / 5.0	
20					372.4				
		(22.2-22.4) (SP) SAND, fine sand, some non-plastic fines; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	SP		22.2 372.2				
		(22.4-25.0) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; dark gray (N3); cohesive, w<PL, soft	ML		22.4 369.6	5	SO	9.1 / 10.0	
25		(25.0-25.2) (SP) SAND, fine sand, some non-plastic fines; moderate yellowish brown (10YR 5/4); non-cohesive, wet, compact	SP CL		25.0 369.4				
		(25.2-26.1) (CL) SILTY CLAY, low to medium plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2); cohesive, w<PL, firm			25.2 368.5				
		(26.1-30.0) (GW) sandy GRAVEL, fine to coarse sub-rounded gravel, fine sand, trace non-plastic fines; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	GW		26.1				
30					364.6				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/22/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 936,750.84 E: 864,447.17

ELEVATION: 394.63
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-55.0) (CL) SILTY CLAY, medium to high plasticity fines, trace sub-rounded gravels; moderate brown (5YR3/4); cohesive, w~PL, stiff	CL		30.0				
35		(34.8) SAA except, olive gray (5Y 4/1)			359.8 34.8	6	SO	10.0 10.0	
40		(40.0) SAA except, less gravel			354.6 40.0				(40.0) Run #7, Driller adds 5 feet of sample rod to the sampler in order to sample a 15 feet run to total depth.
45						7	SO	10.7 15.0	
50									
55		END OF BORING AT 55.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-3.			339.6 55.0				
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-4

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/22/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,618.00 E: 864,629.82

ELEVATION: 402.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-12.4) (ML) CLAYEY SILT, low to medium plasticity fines, some fine sand; dark yellowish brown (10YR 4/2); cohesive, w~PL, firm				1	SO	3.5/5.0	
5		(5.0) SAA (Same As Above) except, trace fine sub-angular gravel; w<PL	ML		397.0 / 5.0	2	SO	1.8/5.0	
10						3	SO	4.6/5.0	
		(12.4-15.0) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2) to dark gray (N3); cohesive, w<PL, firm	ML		389.6 / 12.4				
15		(15.0-20.0) NO RECOVERY	ML		387.0 / 15.0	4	SO	0.0/5.0	(15.0-20.0) Run # 4, No recovery from 15-20 ft. Driller says sample slipped through the retaining bit. Some CLAYEY SILT found in bit, 15-20 is likely same as above but very soft. ▽ Water Level 18.18 ft bgs 2/16/2016
20		(20.0-40.0) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; brownish gray (5YR 4/1); cohesive, w~PL, stiff			382.0 / 20.0				
25		(26.3) SAA except, soft, w<PL	ML		375.7 / 26.3	5	SO	9.4/10.0	
30		Log continued on next page			372.0				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/22/16
DRILL RIG: Mini Sonic (CDD1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,618.00 E: 864,629.82
ELEVATION: 402.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(20.0-40.0) (ML) CLAYEY SILT, low to medium plasticity fines, trace fine sand; brownish gray (5YR 4/1); cohesive, w~PL, stiff *(Continued)* (30.0) SAA except, some fine sand; w~PL, firm	ML		30.0	6	SO	10.0 / 10.0	
35									
40					362.0				
		(40.0-41.3) (GW) GRAVEL, sub-rounded gravel, some medium plasticity fines, trace fine to coarse sub-rounded sand; moderate yellowish brown (10YR 5/4); non-cohesive, wet, compact	GW		40.0 360.7				
		(41.3-60.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; dark gray (N3); cohesive, w~PL, firm			41.3	7	SO	10.0 / 10.0	
45									
50		(50.0) SAA except, trace coarse sub-rounded gravel; medium dark gray (N4)	CL		352.0 50.0				
55		(54.3) SAA except, no gravel, some fine sand; stiff			347.7 54.3	8	SO	9.8 / 10.0	
60		Log continued on next page			342.0				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-4

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/22/16
DRILL RIG: Mini Sonic (CDD1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,618.00 E: 864,629.82
ELEVATION: 402.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(60.0-65.0) (ML) SILT, low plasticity fines, trace sub-angular gravel, trace fine sand; brownish gray (5YR 4/1); cohesive, w<PL, firm	ML		60.0	9	SO	5.0 / 5.0	
65		END OF BORING AT 65.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-4.			337.0 65.0				
70									
75									
80									
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-5

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/21/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 934,874.35 E: 864,780.96

ELEVATION: 400.83
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-10.0) FILL - (CL) SILTY CLAY, medium plasticity fines, trace fine sand, some organics (tree and grass roots); dark yellowish brown (10YR 4/2); cohesive, w~PL, firm				1	SO	4.5 / 5.0	
5		(5.0) SAA (Same As Above) except, greenish black (5GY 2/1); stiff	CL		395.8 / 5.0	2	SO	4.9 / 5.0	
10		(10.0-20.0) FILL - (ML) CLAYEY SILT, non-plastic to low plasticity fines, trace fine sand; brownish black (5YR 2/1) to grayish black (N2), ASH; cohesive, w<PL, soft			390.8 / 10.0	3	SO	5.0 / 5.0	
15		(15.0) SAA except, medium dark gray (N4) mottled moderate yellowish brown (10YR 5/4)	ML		385.8 / 15.0	4	SO	4.9 / 5.0	▽ Water Level 16.79 ft bgs 2/16/2016
20		(20.0-30.0) (CL) SILTY CLAY, low plasticity fines; dusky yellowish brown (10YR 2/2) to dark gray (N3); cohesive, w<PL, firm			380.8 / 20.0				
25			CL			5	SO	10.0 / 10.0	
30					370.8				

Log continued on next page

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-5

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/21/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 934,874.35 E: 864,780.96

ELEVATION: 400.83
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-31.9) (SW) SAND, fine to coarse sub-rounded sand, fine sub-rounded gravel; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	SW		30.0 / 368.9				
		(31.9-33.3) (CL) SILTY CLAY, low to medium plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w~PL, firm	CL		31.9 / 367.5				
		(33.3-35.0) (SC) CLAYEY SAND, fine to coarse sub-rounded sand, low to medium plasticity fines; medium dark gray (N4); non-cohesive, wet, compact	SC		33.3 / 365.8				
35		(35.0-46.0) (CL) SILTY CLAY, low to medium plasticity fines; dark gray (N3); cohesive, w~PL firm	CL		35.0 / 354.8	6	SO	10.0 / 10.0	
40						7	SO	5.0 / 5.0	
45									
		(46.0-60.6) (SW) SAND, fine to coarse sub-rounded sand, some sub-rounded gravel; dark gray (N3); non-cohesive, wet, compact	SW		46.0	8	SO	8.8 / 10.0	
50									
55						9	SO	2.4 / 5.6	
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-5

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/21/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 934,874.35 E: 864,780.96

ELEVATION: 400.83
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60			SW		340.2	9	SO		
		END OF BORING AT 60.6 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-5.			60.6				
65									
70									
75									
80									
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-6

SHEET 1 of 2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/21/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 933,905.19 E: 865,153.48

ELEVATION: 415.84
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-12.9) FILL - (ML) sandy SILT, non-plastic fines, fine sand; dusky yellowish brown (10YR 2.2); non-cohesive, dry, loose	ML		410.8 / 5.0	1	SO	5.0 / 5.0	
5		(5.0) SAA (Same As Above) except, some organics (tree and grass roots)	ML		405.8 / 10.0	2	SO	3.8 / 5.0	
10		(10.0) SAA except, wet	ML		402.9 / 12.9	3	SO	4.9 / 5.0	
		(12.9-15.0) FILL - (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; moderate brown (5YR 3/4); cohesive, w<PL, soft	CL		400.8 / 15.0				
15		(15.0-20.0) NO RECOVERY	CL		395.8 / 20.0	4	SO	0.0 / 5.0	(15.0-20.0) Run # 4, No recovery from 15-20 ft. Driller says sample slipped through the retaining bit. Some SILTY CLAY found in bit, 15-20 is likely same as above but very soft.
20		(20.0-30.0) (CL) SILTY CLAY, medium to high plasticity fines, trace fine sand; duskly yellowish brown (10YR 2/2); cohesive, w~PL, firm	CL		385.8	5	SO	3.0 / 10.0	(20.0-30.0) Run # 5, poor recovery because driller dropped contents of bag on ground
25									
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-6

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/21/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 933,905.19 E: 865,153.48

ELEVATION: 415.84
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-42.2) (ML) sandy SILT, non-plastic fines, fine sand; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	ML		30.0	6	SO	6.8 / 15.0	(30.0) Run 6, (40.0) Driller adds 5 feet of sample rod to the sampler in order to sample a 15 feet run. ▽ Water Level 31.32 ft bgs 2/16/2016
35									
40					373.6				
		(42.2-52.0) (SW) SAND, fine to coarse sub-rounded sand, trace non-plastic fines; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	SW		42.2				
45		(45.0) SAA except, no fines; medium gray (N5)			370.8 / 45.0	7	SO	9.8 / 10.0	
50					363.8				
		(52.0-55.0) (SP) SAND, fine sand; medium gray (N5); non-cohesive, wet, compact	SP		52.0				
55		END OF BORING AT 55.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-6.			360.8 / 55.0				
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-7

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 934,334.40 E: 866,242.50

ELEVATION: 415.67
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-6.3) (ML) SILT, non-plastic to low plasticity fines, trace sub-angular gravel in upper 0.5 ft; dusky brown (5YR 2/2); cohesive, w<PL, stiff	ML			1	SO	3.0 / 5.0	
5		(5.0) SAA (Same As Above) except, firm			410.7 / 5.0				
		(6.3-7.4) (GM) SILTY GRAVEL, fine to coarse sub-angular gravel, non-plastic fines, trace fine to coarse sub-rounded sand; dusky yellowish brown (10YR 2/2); non-cohesive, wet, compact	GM		409.4 / 6.3	2	SO	5.0 / 5.0	
		(7.4-11.2) (ML) CLAYEY SILT, low plasticity fines, some fine sand; dark yellowish brown (10YR 4/2); cohesive, w<PL, firm	ML		408.3 / 7.4				
10		(11.2-21.9) (ML) sandy SILT, non-plastic to low plasticity fines, fine sand, trace sub-rounded gravel; dusky yellowish brown (10YR 2/2); cohesive, w<PL, soft	ML		404.5 / 11.2	3	SO	4.0 / 5.0	
15						4	SO	2.7 / 5.0	
20		(21.9-23.6) (CL) SILTY CLAY, medium to high plasticity fines; dark yellowish brown (10YR 4/2); cohesive, w~PL, firm	CL		393.8 / 21.9				
		(23.6-40.0) (SP & ML) SAND & SILT, fine sand, non-plastic fines; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	SP & ML		392.1 / 23.6	5	SO	4.9 / 10.0	
25									
30		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

RECORD OF BOREHOLE MW-7

SHEET 2 of 2

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/23/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 934,334.40 E: 866,242.50

ELEVATION: 415.67
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(23.6-40.0) (SP & ML) SAND & SILT, fine sand, non-plastic fines; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact *(Continued)*	SP & ML			6	SO	6.5 / 10.0	▽ Water Level 30.99 ft bgs 2/16/2016
35									
40					375.7 40.0				
		(40.0-52.7) (SW) SAND, fine to coarse sub-rounded sand, trace sub-rounded fine gravel; dusky yellowish brown (10YR 4/2); non-cohesive, wet, compact	SW			7	SO	6.4 / 10.0	
45									
50		(50.0) SAA except, no gravel			365.7 50.0	8	SO	2.0 / 2.7	
		END OF BORING AT 52.7 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-7.			363.0 52.7				
55									
60									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-8

SHEET 1 of 3

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center

DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/24/16
DRILL RIG: Mini Sonic (CDD1415)

DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,303.55 E: 866,797.84

ELEVATION: 421.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
0	6" Sonic	(0.0-0.9) FILL - (GW) sandy GRAVEL, fine to coarse sub-angular gravel, fine sand; dark gray (N3); non-cohesive, dry, loose	GW		420.1				
		(0.9-1.2) FILL - (SW) SAND, fine to coarse sub-rounded sand; moderate yellowish brown (10YR 5/4); non-cohesive, dry, loose	SW		0.9 419.8 1.2				
		(1.2-7.1) (ML) sandy SILT, non-plastic fines, fine sand, trace sub-rounded gravel; dusky yellowish brown (10YR 2/2); non-cohesive, dry, compact	ML			1	SO	4.8 / 5.0	
5		(5.0) SAA (Same As Above) except, some sand, some gravel; moist			416.0 5.0				
		(7.1-10.0) (ML) CLAYEY SILT, low plasticity fines, trace fine sand; dark yellowish brown (10YR 4/2); cohesive, w<PL, stiff	ML		413.9 7.1	2	SO	3.9 / 5.0	
10		(10.0-20.0) (CL) SILTY CLAY, high plasticity fines; brownish gray (5YR 4/1); cohesive, w~PL, stiff	CL		411.0 10.0	3	SO	9.6 / 10.0	
15									
20		(20.0-21.7) (SC) CLAYEY SAND, fine to coarse sub-rounded sand, medium plasticity fines; brownish gray (5YR 4/1); non-cohesive, wet, compact	SC		401.0 20.0				
		(21.7-30.0) (CL) SILTY CLAY, high plasticity fines, trace fine sand; medium dark gray (N3); cohesive, w>PL, very stiff	CL		399.3 21.7	4	SO	4.7 / 10.0	
25									
30		Log continued on next page			391.0				

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-8

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/24/16
DRILL RIG: Mini Sonic (CDD1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,303.55 E: 866,797.84
ELEVATION: 421.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
30	6" Sonic	(30.0-32.8) (ML) sandy SILT, non-plastic fines, fine sand; dark yellowish brown (10YR 4/2); non-cohesive, wet, compact	ML		30.0 / 388.2				
		(32.8-40.0) (CL) SILTY CLAY, low plasticity fines; brownish gray (5YR 4/1); cohesive, w<PL, stiff	CL		32.8 / 381.0	5	SO	9.2 / 10.0	▽ Water Level 35.86 ft bgs 2/16/2016
40		(40.0-50.0) (CL) SILTY CLAY, medium plasticity fines; medium dark gray (N3); cohesive, w~PL, firm	CL		40.0	6	SO	10.0 / 10.0	
		(48.8) SAA except, soft			372.5 / 48.5				
		(49.2) SAA except, firm			371.8 / 49.2 / 371.0				
50		(50.0-68.0) (ML) sandy SILT, non-plastic fines, fine sand; medium dark gray (N4); non-cohesive, wet, compact	ML		50.0	7	SO	10.0 / 10.0	
55									
60		Log continued on next page							

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek
LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

RECORD OF BOREHOLE MW-8

PROJECT: Ameren CCR GW Monitoring
PROJECT NUMBER: 153-1406.0004A
LOCATION: Meramec Energy Center
DRILLING METHOD: 6" Sonic
DRILLING DATE: 1/24/16
DRILL RIG: Mini Sonic (CDD1415)
DATUM: NAVD88
AZIMUTH: N/A
COORDINATES: N: 935,303.55 E: 866,797.84
ELEVATION: 421.03
INCLINATION: -90

DEPTH (feet)	BORING METHOD	SOIL/ROCK PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEVATION / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC / ATT	REMARKS
60	6" Sonic	(50.0-68.0) (ML) sandy SILT, non-plastic fines, fine sand; medium dark gray (N4); non-cohesive, wet, compact *(Continued)*	ML						
65						8	SO	10.0 / 10.0	
					353.0				
		(68.0-75.5) (SM) SILTY SAND, fine poorly graded sand, non-plastic fines; medium dark gray (N4); non-cohesive, wet, compact			68.0				
70			SM						
75						9	SO	10.0 / 10.0	
					345.5				
		(75.5-75.9) (SW) SAND, fine to coarse sub-rounded sand, trace coarse sub-rounded gravel; brownish gray (5YR 4/1); non-cohesive, wet, compact	SW		75.5				
					345.1				
		(75.9-80.0) (CL) SILTY CLAY, low plasticity fines, trace fine sand; medium dark gray (N4); cohesive, w~PL, stiff	CL		75.9				
80					341.0				
		END OF BORING AT 80.0 FEET BELOW GROUND SURFACE. FOR WELL DETAILS, SEE WELL CONSTRUCTION LOG MW-8.			80.0				
85									
90									

SCALE: 1 in = 3.8 ft
DRILLING CONTRACTOR: Cascade
DRILLER: J. Drabek

LOGGED: JS
CHECKED: JSI
REVIEWED: PJJ/MNH

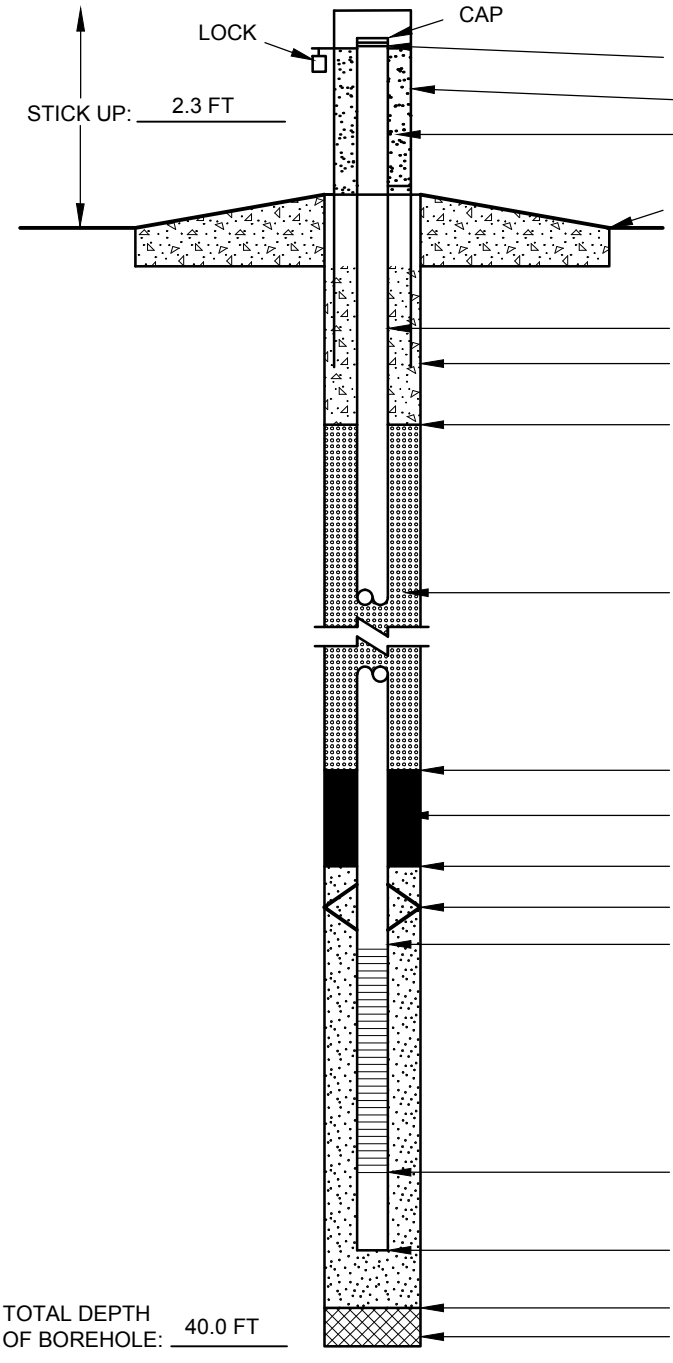
Golder Associates

GOLDER STL RECORD OF BOREHOLE MWD MEC LOGS.GPJ GLDR_CO.GDT 10/10/17

APPENDIX E
CCR MONITORING WELL CONSTRUCTION DIAGRAMS

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-1

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: MW-1	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 404.1 FT MSL	
GEOLOGIST: J. SUOZZI	NORTHING: 937676.9	EASTING: 865954.1
DRILLER: J. DRABEK	STATIC WATER LEVEL: 4.56 FT BTOC	COMPLETION DATE: 1/23/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



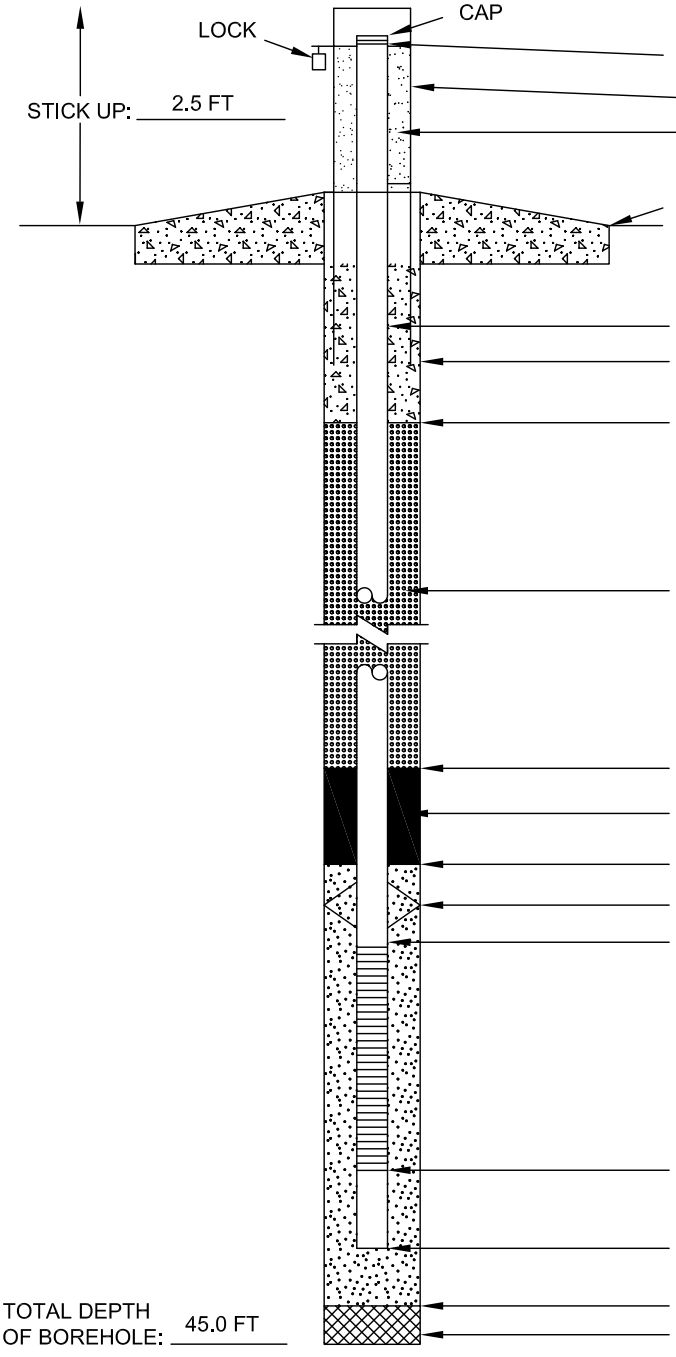
- TOP OF CASING ELEVATION: 406.43 FT MSL
- PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM
- PEA GRAVEL OR SAND
- GROUND SURFACE ELEVATION: 404.1 FT MSL
- DIAMETER OF RISER PIPE (in.): 2.0
- DIAMETER OF BOREHOLE (in.): 6.0
- CONCRETE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF ANNULAR SEAL: NONE
- TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 5 $\frac{1}{2}$ BAGS
- TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 31.5 FINE: 30.0
- CENTRALIZER (yes / no) - TYPE: NONE
- TOP OF SCREEN DEPTH (ft. bgs): 33.9
- TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC
- SCREEN SLOT SIZE (in.): 0.010 IN
- SIZE OF SAND PACK: COARSE: #1 FINE: #0
- AMOUNT OF SAND: COARSE: 2 BAGS FINE: $\frac{1}{3}$ BAG
- BOTTOM OF SCREEN DEPTH (ft. bgs): 38.7
- BOTTOM OF WELL DEPTH (ft. bgs): 39.1
- BOTTOM OF FILTER PACK (ft. bgs): 39.1
- TYPE AND AMOUNT OF BACKFILL: 0.9 FT - NATURAL CAVE IN

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
125 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM
DATE CHECKED: 4/25/2016
PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-2

PROJECT NAME: AMEREN CCR GW MONITORING		PROJECT NUMBER: 153-1406.0004A
SITE NAME: MERAMEC ENERGY CENTER		LOCATION: MW-2
CLIENT: AMEREN MISSOURI		SURFACE ELEVATION: 396.1 FT MSL
GEOLOGIST: J. SUOZZI	NORTHING: 937325.1	EASTING: 864864.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 15.06 FT BTOC	COMPLETION DATE: 1/23/2016
DRILLING COMPANY: CASCADE		DRILLING METHODS: SONIC



TOP OF CASING ELEVATION: 398.62 FT MSL

PROTECTIVE CASING (yes) / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 396.1 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 4 $\frac{1}{2}$ BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 27.0 FINE: 26.0

CENTRALIZER (yes / (no) - TYPE: NONE

TOP OF SCREEN DEPTH (ft. bgs): 29.12

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2 BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 33.9

BOTTOM OF WELL DEPTH (ft. bgs): 34.3

BOTTOM OF FILTER PACK (ft. bgs): 35.0

TYPE AND AMOUNT OF BACKFILL: 10.0 FT - 1.5 BAGS BENTONITE CHIPS

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
150 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

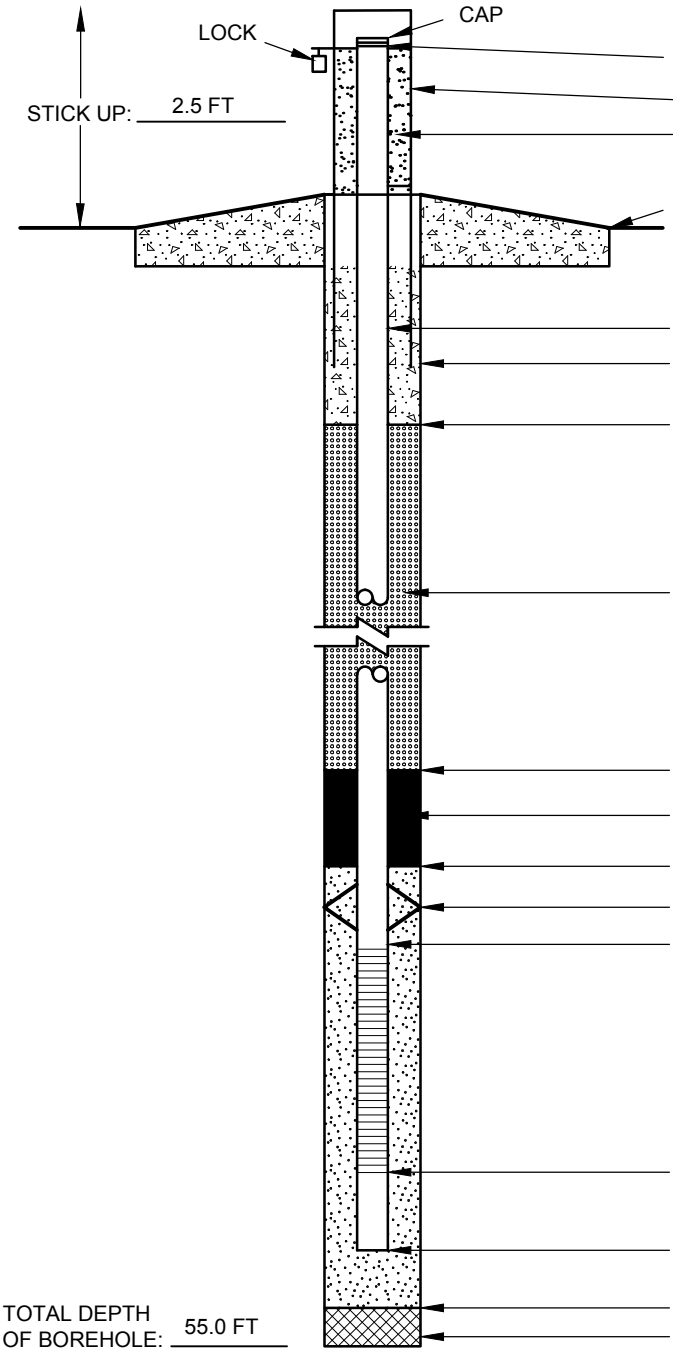
CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-3

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: MW-3	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 394.6 FT MSL	
GEOLOGIST: J. SUOZZI	NORTHING: 936750.8	EASTING: 864447.2
DRILLER: J. DRABEK	STATIC WATER LEVEL: 13.56 FT BTOC	COMPLETION DATE: 1/22/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 397.12 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 394.6 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 5 BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 23.0 FINE: 22.0

CENTRALIZER (yes / no) - TYPE: NONE

TOP OF SCREEN DEPTH (ft. bgs): 25.4

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2 BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 30.2

BOTTOM OF WELL DEPTH (ft. bgs): 30.6

BOTTOM OF FILTER PACK (ft. bgs): 31.5

TYPE AND AMOUNT OF BACKFILL: 23.5 FEET - 3 BAGS BENTONITE CHIPS

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
150 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

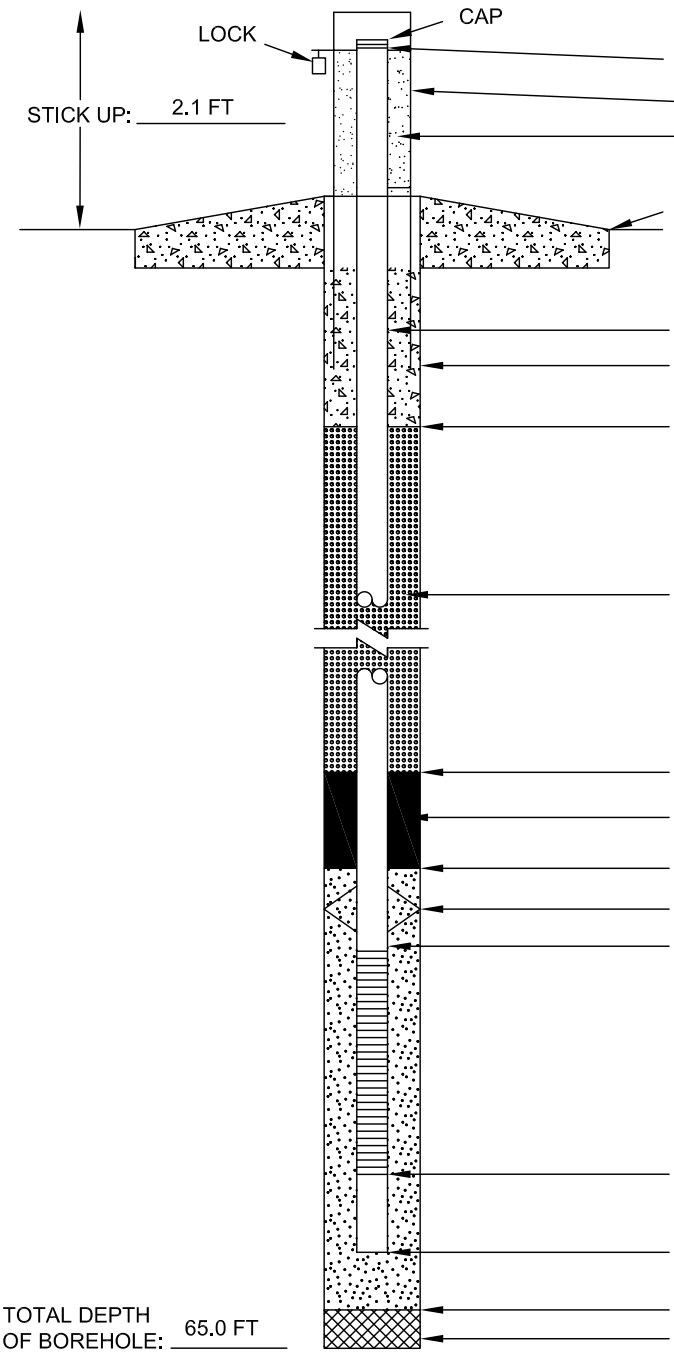
CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-4

PROJECT NAME: AMEREN CCR GW MONITORING		PROJECT NUMBER: 153-1406.0004A
SITE NAME: MERAMEC ENERGY CENTER		LOCATION: MW-4
CLIENT: AMEREN MISSOURI		SURFACE ELEVATION: 402.0 FT MSL
GEOLOGIST: J. SUOZZI	NORTHING: 935618.0	EASTING: 864629.8
DRILLER: J. DRABEK	STATIC WATER LEVEL: 20.25 FT BTOC	COMPLETION DATE: 1/22/2016
DRILLING COMPANY: CASCADE		DRILLING METHODS: SONIC



TOP OF CASING ELEVATION: 404.10 FT MSL

PROTECTIVE CASING (yes) / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 402.0 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 6 $\frac{1}{2}$ BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 35.7 FINE: 34.0

CENTRALIZER (yes / (no) - TYPE: NONE

TOP OF SCREEN DEPTH (ft. bgs): 37.9

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2 BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 42.7

BOTTOM OF WELL DEPTH (ft. bgs): 43.1

BOTTOM OF FILTER PACK (ft. bgs): 45.0

TYPE AND AMOUNT OF BACKFILL: 20.0 FT - 3 $\frac{1}{3}$ BAGS BENTONITE CHIPS

TOTAL DEPTH OF BOREHOLE: 65.0 FT

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
200 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

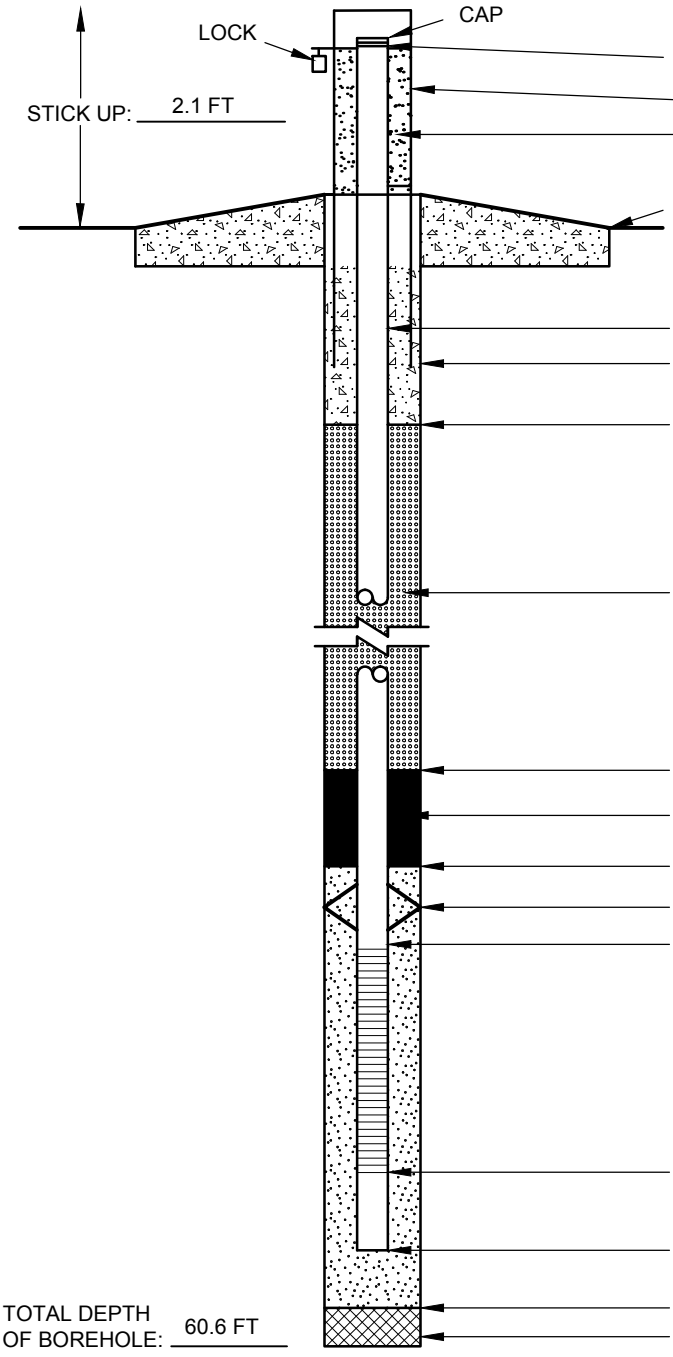
CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-5

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: MW-5	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 400.8 FT MSL	
GEOLOGIST: J. SUOZZI	NORTHING: 934874.4	EASTING: 864781.0
DRILLER: J. DRABEK	STATIC WATER LEVEL: 18.89 FT BTOC	COMPLETION DATE: 1/22/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 402.93 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 400.8 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 8 BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 47.5 FINE: 46.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 50.4

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: $3\frac{1}{4}$ BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 60.2

BOTTOM OF WELL DEPTH (ft. bgs): 60.6

BOTTOM OF FILTER PACK (ft. bgs): 60.6

TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
250 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

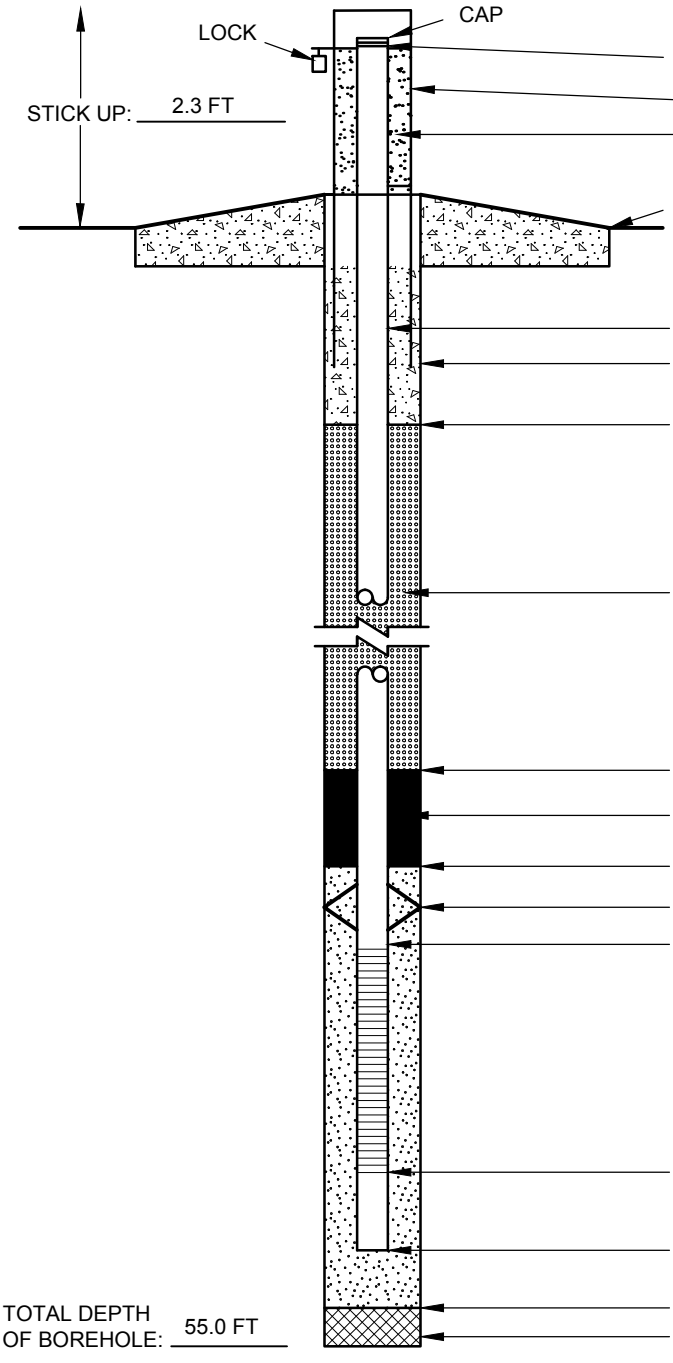
CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-6

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: MW-6	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 415.8 FT MSL	
GEOLOGIST: J. SUOZZI	NORTHING: 933905.2	EASTING: 865153.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 33.60 FT BTOC	COMPLETION DATE: 1/21/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



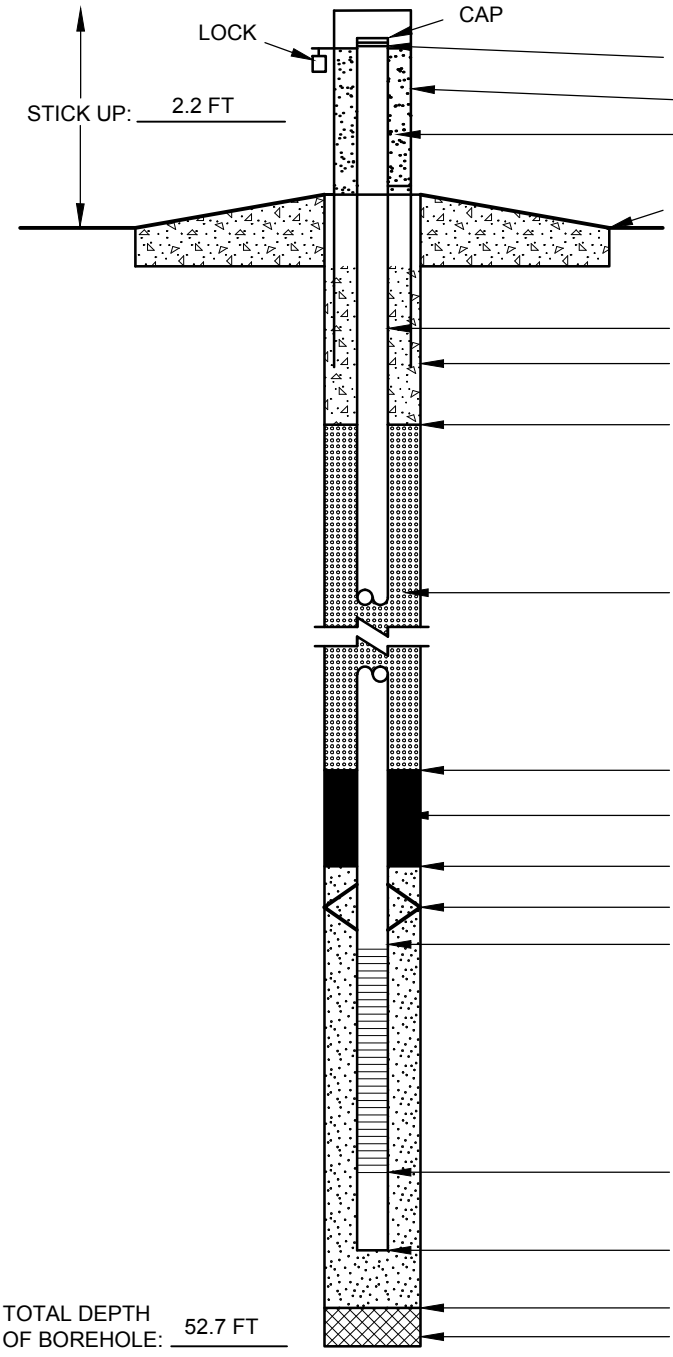
- TOP OF CASING ELEVATION: 418.12 FT MSL
- PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM
- PEA GRAVEL OR SAND
- GROUND SURFACE ELEVATION: 415.8 FT MSL
- DIAMETER OF RISER PIPE (in.): 2.0
- DIAMETER OF BOREHOLE (in.): 6.0
- CONCRETE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF ANNULAR SEAL: NONE
- TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 7 BAGS
- TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 39.7 FINE: 39.0
- CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)
- TOP OF SCREEN DEPTH (ft. bgs): 42.5
- TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC
- SCREEN SLOT SIZE (in.): 0.010 IN
- SIZE OF SAND PACK: COARSE: #1 FINE: #0
- AMOUNT OF SAND: COARSE: 3.5 BAGS FINE: 1/3 BAG
- BOTTOM OF SCREEN DEPTH (ft. bgs): 52.3
- BOTTOM OF WELL DEPTH (ft. bgs): 52.7
- BOTTOM OF FILTER PACK (ft. bgs): 52.7
- TYPE AND AMOUNT OF BACKFILL: 2.3 FEET -NATURAL BACKFILL

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
300 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM
DATE CHECKED: 4/25/2016
PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-7

PROJECT NAME: AMEREN CCR GW MONITORING		PROJECT NUMBER: 153-1406.0004A
SITE NAME: MERAMEC ENERGY CENTER		LOCATION: MW-7
CLIENT: AMEREN MISSOURI		SURFACE ELEVATION: 415.7 FT MSL
GEOLOGIST: J. SUOZZI	NORTHING: 934334.4	EASTING: 866242.5
DRILLER: J. DRABEK	STATIC WATER LEVEL: 33.26 FT BTOC	COMPLETION DATE: 1/24/2016
DRILLING COMPANY: CASCADE		DRILLING METHODS: SONIC



TOP OF CASING ELEVATION: 417.94 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 415.7 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 8 BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 38.5 FINE: 37.0

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 42.5

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2.5 BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 52.3

BOTTOM OF WELL DEPTH (ft. bgs): 52.7

BOTTOM OF FILTER PACK (ft. bgs): 52.7

TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
200 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

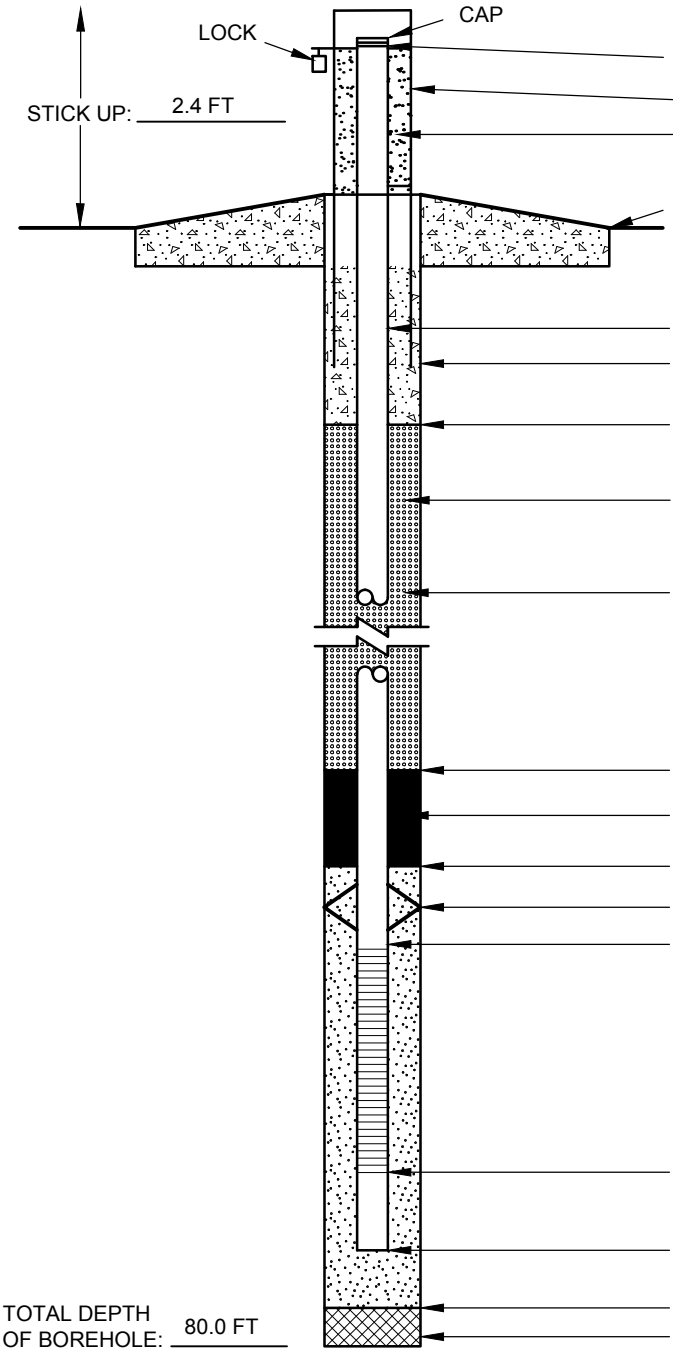
CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG MW-8

PROJECT NAME: AMEREN CCR GW MONITORING		PROJECT NUMBER: 153-1406.0004A
SITE NAME: MERAMEC ENERGY CENTER		LOCATION: MW-8
CLIENT: AMEREN MISSOURI		SURFACE ELEVATION: 421.0 FT MSL
GEOLOGIST: J. SUOZZI	NORTHING: 935303.6	EASTING: 866797.8
DRILLER: J. DRABEK	STATIC WATER LEVEL: 38.20 FT BTOC	COMPLETION DATE: 1/24/2016
DRILLING COMPANY: CASCADE		DRILLING METHODS: SONIC



TOP OF CASING ELEVATION: 423.37 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 421.0 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 3.5 BAGS

TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE 4 BAGS

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 58.0

TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 63.0 FINE: 62.5

CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)

TOP OF SCREEN DEPTH (ft. bgs): 65.2

TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 2.5 BAGS FINE: 1/3 BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 75.0

BOTTOM OF WELL DEPTH (ft. bgs): 75.4

BOTTOM OF FILTER PACK (ft. bgs): 80.0

TYPE AND AMOUNT OF BACKFILL: NONE

ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
250 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM

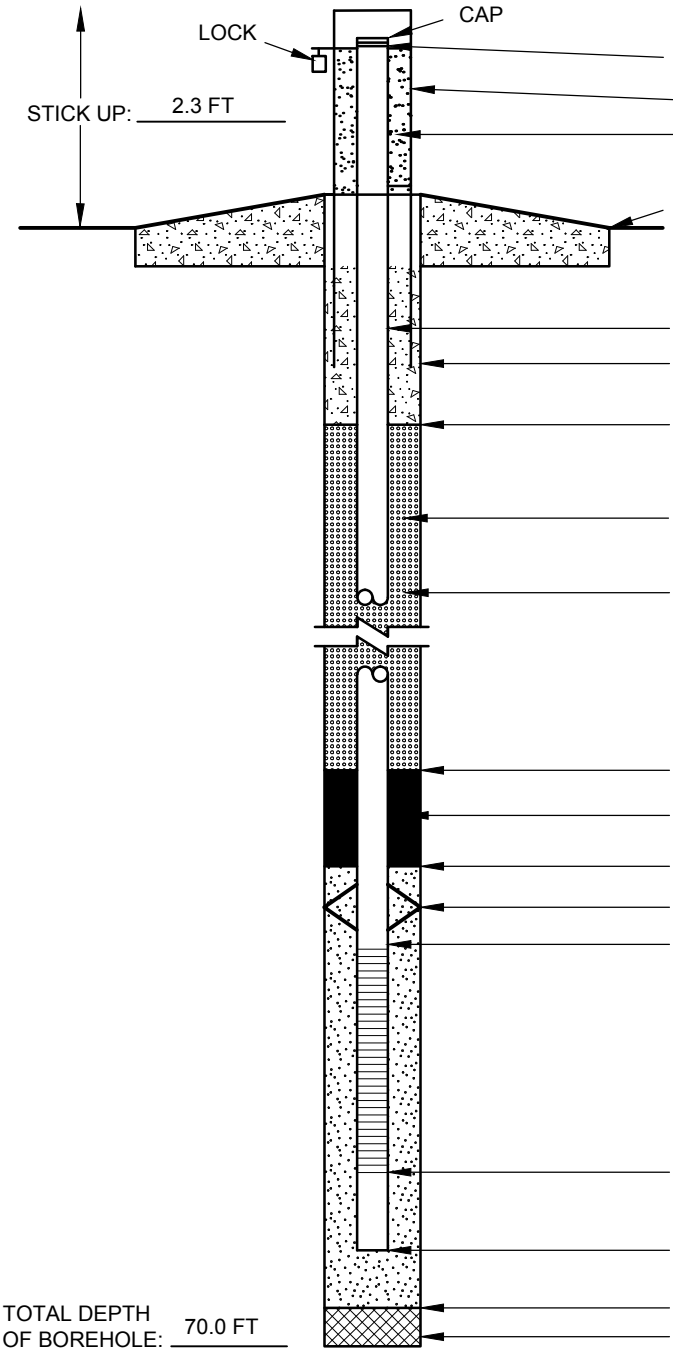
DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG

BMW-1

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: BMW-1	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 416.8 FT MSL	
GEOLOGIST: J. INGRAM	NORTHING: 935220.4	EASTING: 867989.4
DRILLER: J. DRABEK	STATIC WATER LEVEL: 25.42 FT BTOC	COMPLETION DATE: 4/7/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



- TOP OF CASING ELEVATION: 419.08 FT MSL
- PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM
- PEA GRAVEL OR SAND
- GROUND SURFACE ELEVATION: 416.8 FT MSL
- DIAMETER OF RISER PIPE (in.): 2.0
- DIAMETER OF BOREHOLE (in.): 6.0
- CONCRETE SEAL DEPTH (ft. bgs): 2.5
- TYPE AND AMOUNT OF ANNULAR SEAL: 3/8" BENTONITE CHIPS - 2 BAGS
- TYPE AND AMOUNT OF ANNULAR SEAL: HIGH SOLIDS BENTONITE, 3 BAGS
- TOP OF BENTONITE SEAL DEPTH (ft. bgs): 40.0
- TYPE AND AMOUNT OF BENTONITE SEAL: 3/8" BENTONITE CHIPS - 1 BAG
- TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 46.5 FINE: 45.0
- CENTRALIZER (yes / no) - TYPE: STAINLESS STEEL (TOP + BOTTOM)
- TOP OF SCREEN DEPTH (ft. bgs): 50.4
- TYPE OF SCREEN: 2" X 9.8' SCHEDULE 40 PVC
- SCREEN SLOT SIZE (in.): 0.010 IN
- SIZE OF SAND PACK: COARSE: #1 FINE: #0
- AMOUNT OF SAND: COARSE: 4 BAGS FINE: 0.5 BAG
- BOTTOM OF SCREEN DEPTH (ft. bgs): 60.2
- BOTTOM OF WELL DEPTH (ft. bgs): 60.6
- BOTTOM OF FILTER PACK (ft. bgs): 62.0
- TYPE AND AMOUNT OF BACKFILL: 3/8" CHIPS: 62.0-68.0 ft. bgs; CAVE IN: 68.0-70.0 ft. bgs

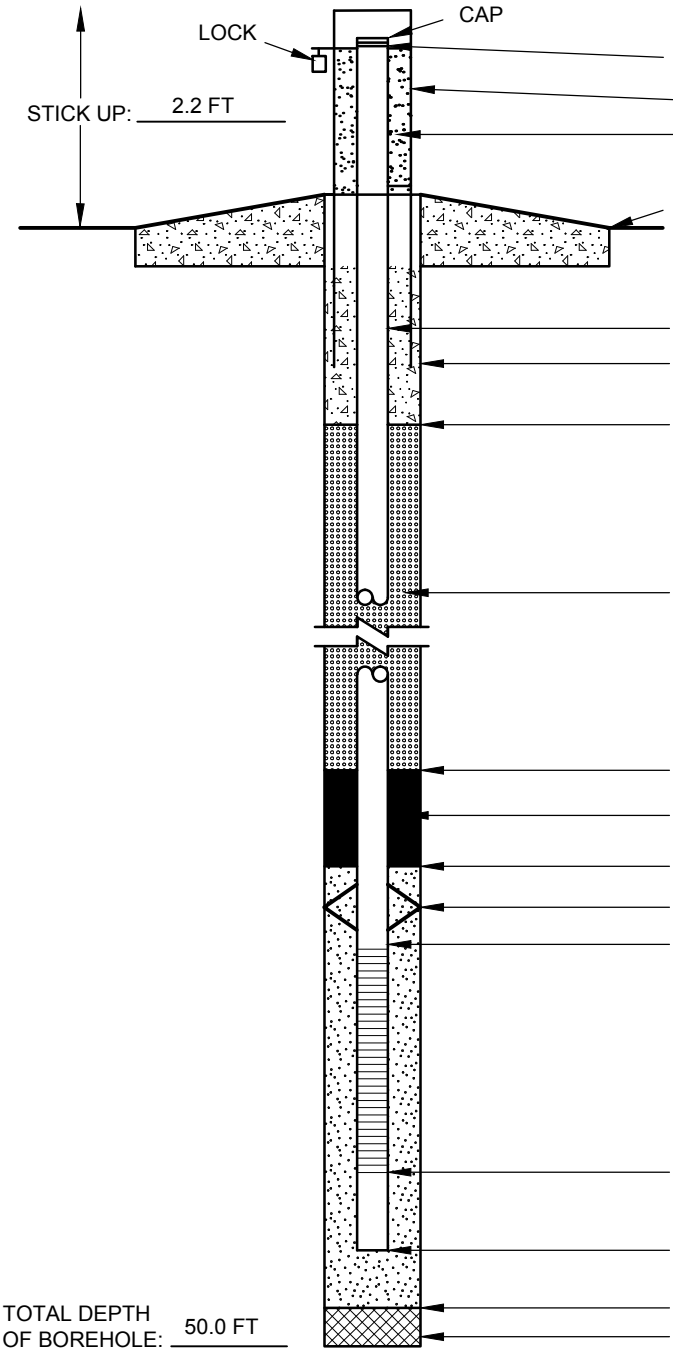
ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
200 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON APRIL 28, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM
DATE CHECKED: 6/2/2016

PREPARED BY: J. SUOZZI

ABOVE GROUND MONITORING WELL CONSTRUCTION LOG BMW-2

PROJECT NAME: AMEREN CCR GW MONITORING	PROJECT NUMBER: 153-1406.0004A	
SITE NAME: MERAMEC ENERGY CENTER	LOCATION: BMW-2	
CLIENT: AMEREN MISSOURI	SURFACE ELEVATION: 406.8 FT MSL	
GEOLOGIST: J. SUOZZI	NORTHING: 937927.1	EASTING: 866342.2
DRILLER: J. DRABEK	STATIC WATER LEVEL: 14.11 FT BTOC	COMPLETION DATE: 1/25/2016
DRILLING COMPANY: CASCADE	DRILLING METHODS: SONIC	



TOP OF CASING ELEVATION: 409.02 FT MSL

PROTECTIVE CASING (yes / no): 4" X 5' ALUMINUM

PEA GRAVEL OR SAND

GROUND SURFACE ELEVATION: 406.8 FT MSL

DIAMETER OF RISER PIPE (in.): 2.0

DIAMETER OF BOREHOLE (in.): 6.0

CONCRETE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF ANNULAR SEAL: NONE

TOP OF BENTONITE SEAL DEPTH (ft. bgs): 2.5

TYPE AND AMOUNT OF BENTONITE SEAL: $\frac{3}{8}$" BENTONITE CHIPS - 6 $\frac{1}{2}$ BAGS

TOP OF SAND PACK DEPTH (ft. bgs): COARSE: 34.7 FINE: 34.0

CENTRALIZER (yes / no) - TYPE: NONE

TOP OF SCREEN DEPTH (ft. bgs): 37.5

TYPE OF SCREEN: 2" X 4.8' SCHEDULE 40 PVC

SCREEN SLOT SIZE (in.): 0.010 IN

SIZE OF SAND PACK: COARSE: #1 FINE: #0

AMOUNT OF SAND: COARSE: 1.75 BAGS FINE: $\frac{1}{3}$ BAG

BOTTOM OF SCREEN DEPTH (ft. bgs): 42.3

BOTTOM OF WELL DEPTH (ft. bgs): 42.7

BOTTOM OF FILTER PACK (ft. bgs): 44.0

TYPE AND AMOUNT OF BACKFILL: BENTONITE CHIPS - 1 BAG - 6.0 FT

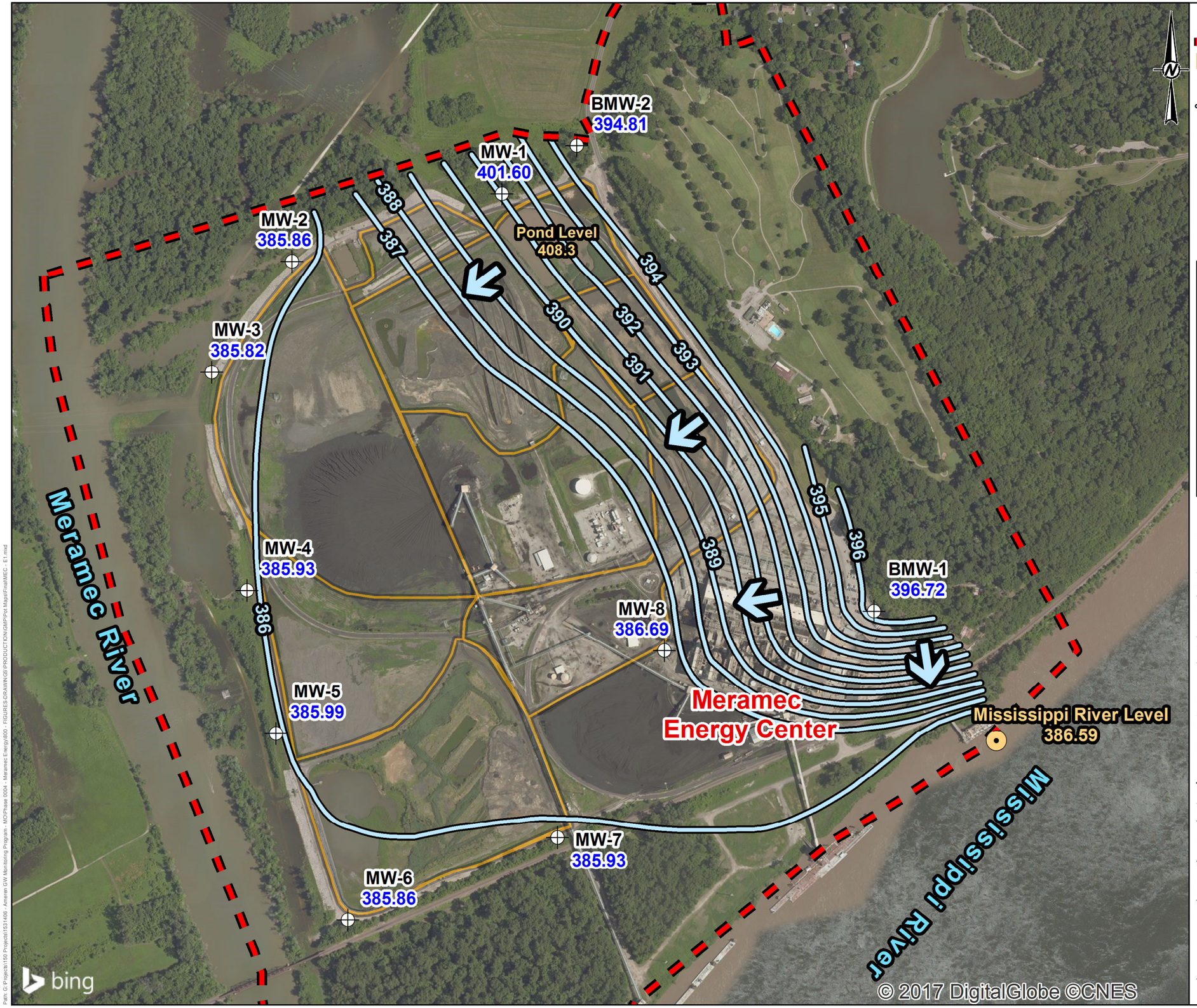
ADDITIONAL NOTES: FT BGS = FEET BELOW GROUND SURFACE. FT MSL = FEET ABOVE MEAN SEA LEVEL.
120 GALLONS OF H2O USED DURING DRILLING. HORIZONTAL DATUM: STATE PLANE COORDINATES NAD83 US SURVEY FT (2000) MISSOURI EAST ZONE. VERTICAL DATUM: NAVD88. WELL SURVEYED BY ZAHNER AND ASSOCIATES, INC ON FEBRUARY 4, 2016.
FT BTOC = FEET BELOW TOP OF CASING. SAND AND BENTONITE BAGS WEIGH 50 LBS EACH.

CHECKED BY: J. INGRAM

DATE CHECKED: 4/25/2016

PREPARED BY: J. SUOZZI

APPENDIX F
POTENTIOMETRIC SURFACE MAPS FROM BACKGROUND CCR SAMPLING EVENTS



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

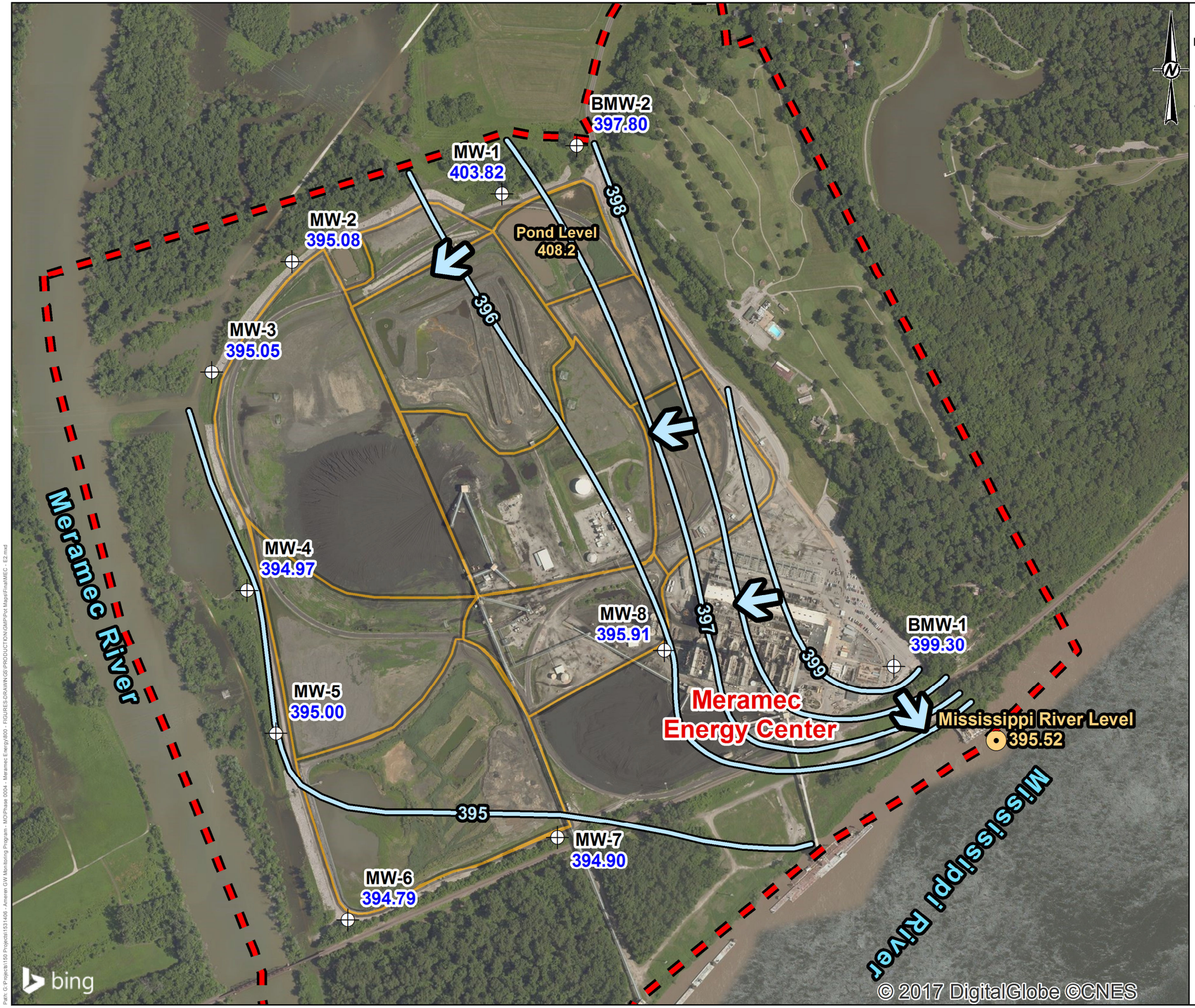
TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 1 - MARCH 28, 2016

CONSULTANT
Golder Associates

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

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P1**

AMEREN_00000701



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

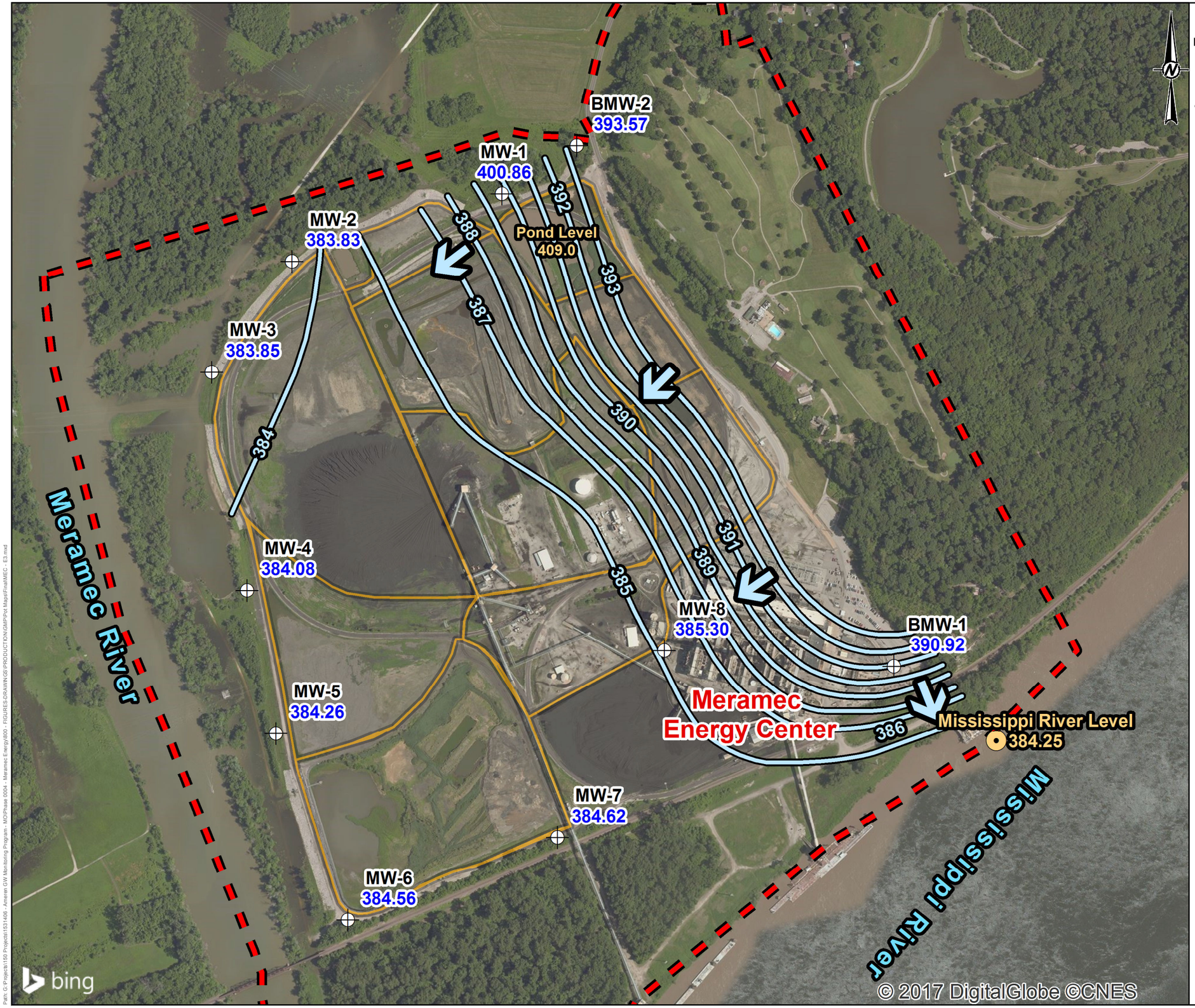
TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 2 - MAY 13, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-05-24
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0004A	0.0	**P2**

AMEREN_00000702



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 3 - JULY 18, 2016

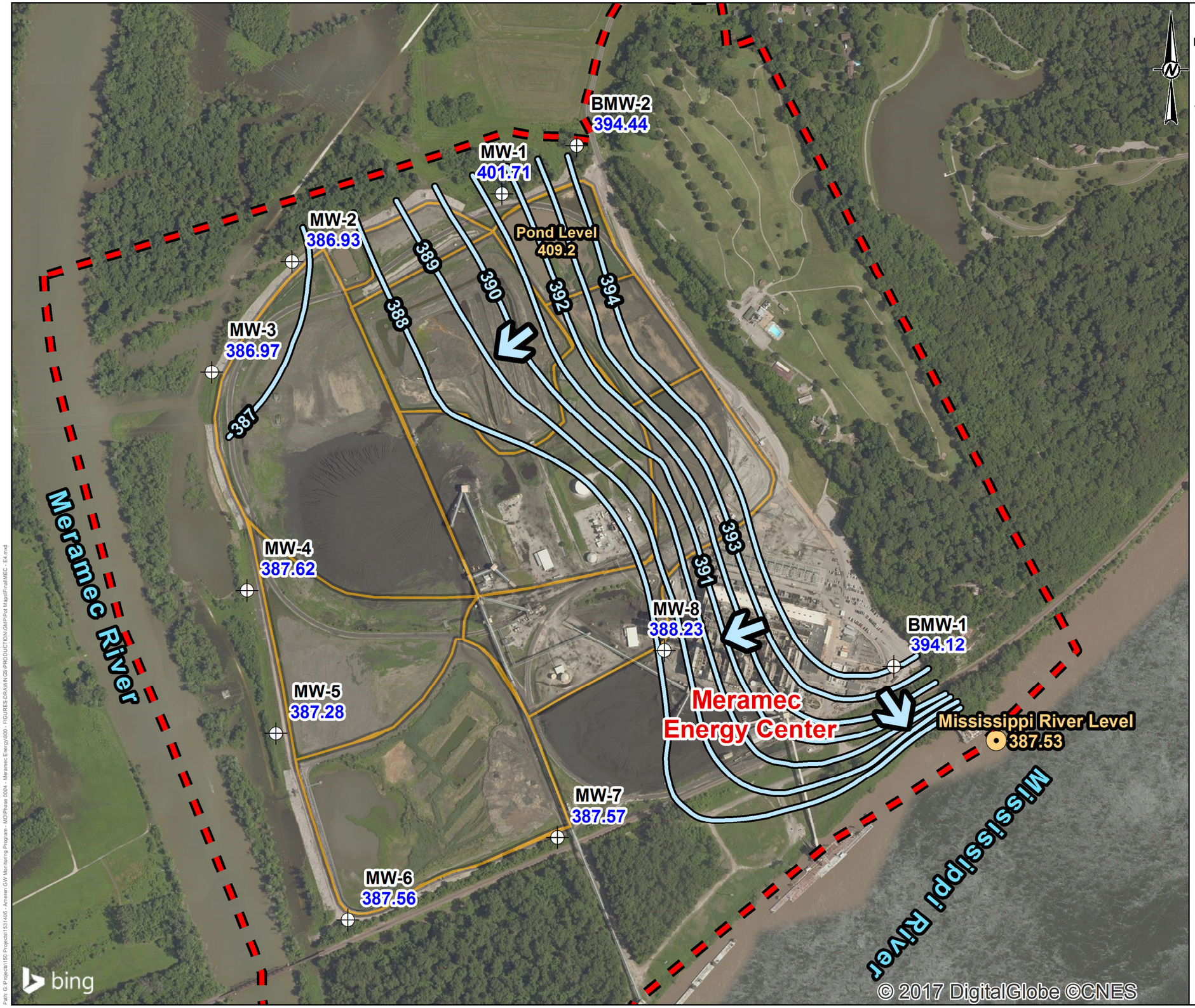
CONSULTANT
Golder Associates

YYYY-MM-DD	2016-08-16
PREPARED	JS
DESIGN	JS
REVIEW	JSI
APPROVED	MNH

PROJECT No.	PHASE	Rev.	FIGURE
153-1406	0004A	0.0	**P3**

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

Path: G:\Projects\150 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP\Pot Maps\FinalMEC - E3.mxd



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 4 - SEPTEMBER 7, 2016

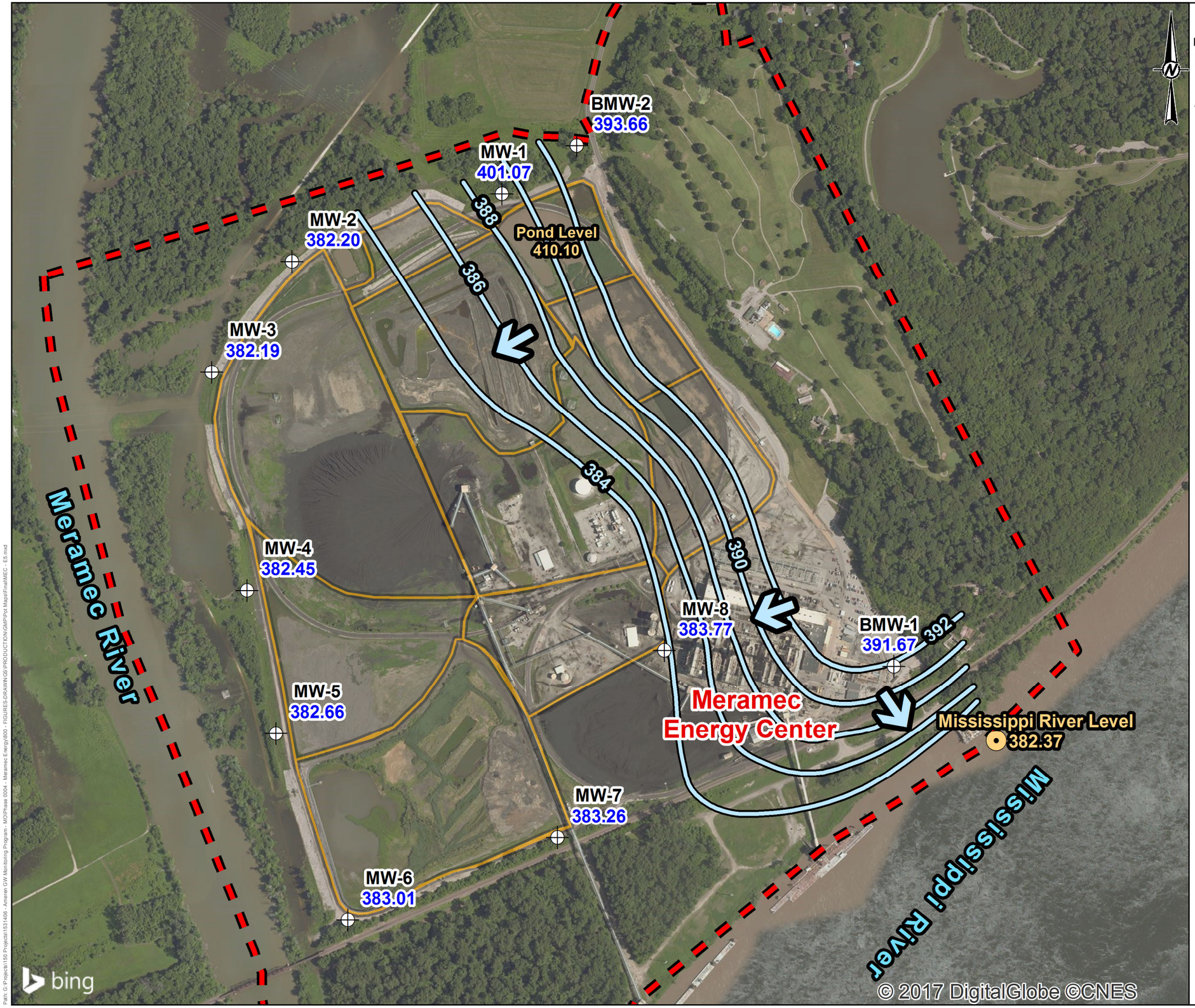
CONSULTANT
Golder Associates

YYYY-MM-DD	2017-09-27
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P4**

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 0004 - Meramec Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP\Pot Maps\FinalMEC - E4.mxd



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 5 - NOVEMBER 10, 2016

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-11-21
PREPARED	JSI
DESIGN	JSI
REVIEW	MSG
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P5**

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

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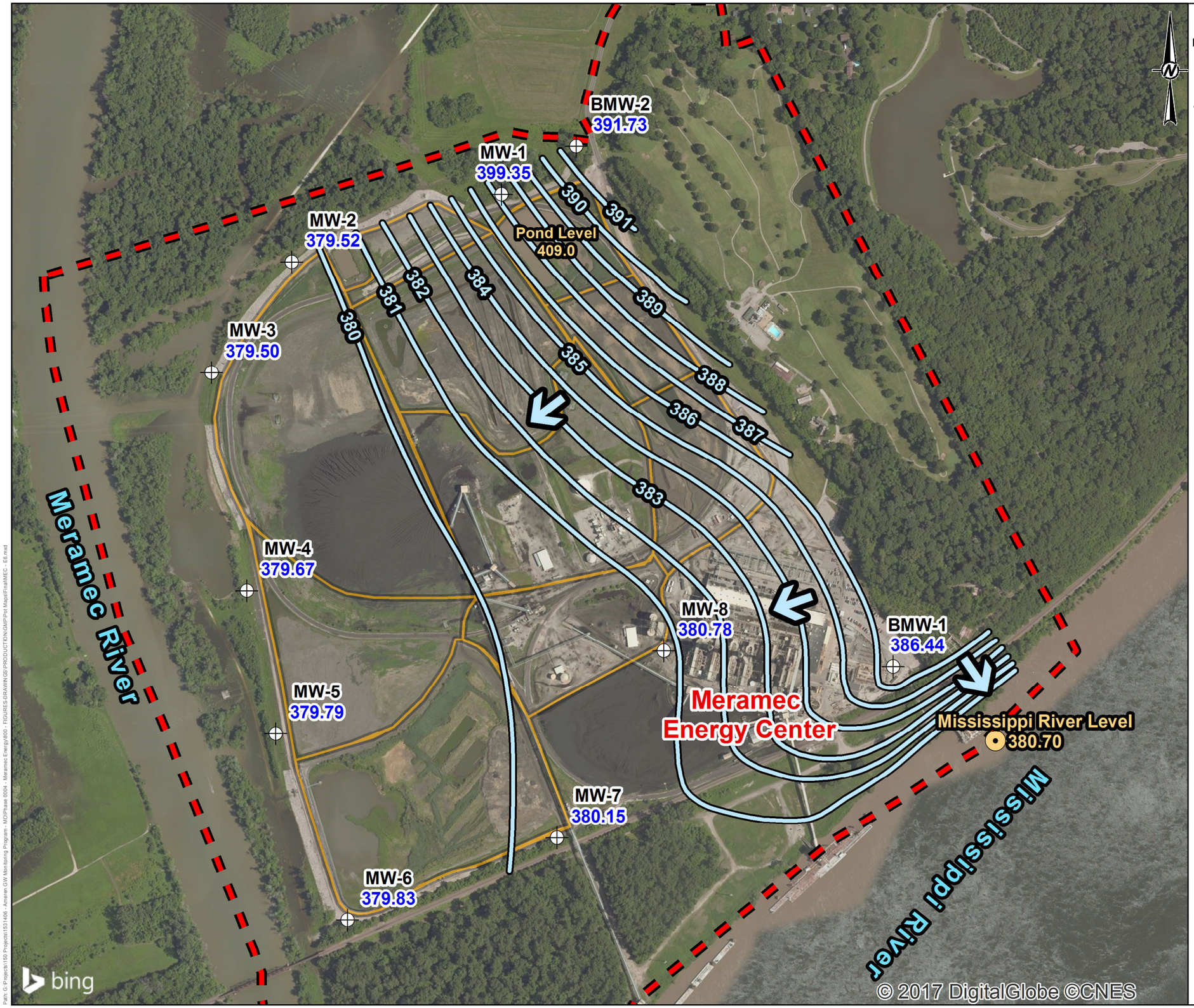

LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

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

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-23
PREPARED	JS
DESIGN	JSI
REVIEW	BEF
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P6**

AMEREN_00000706

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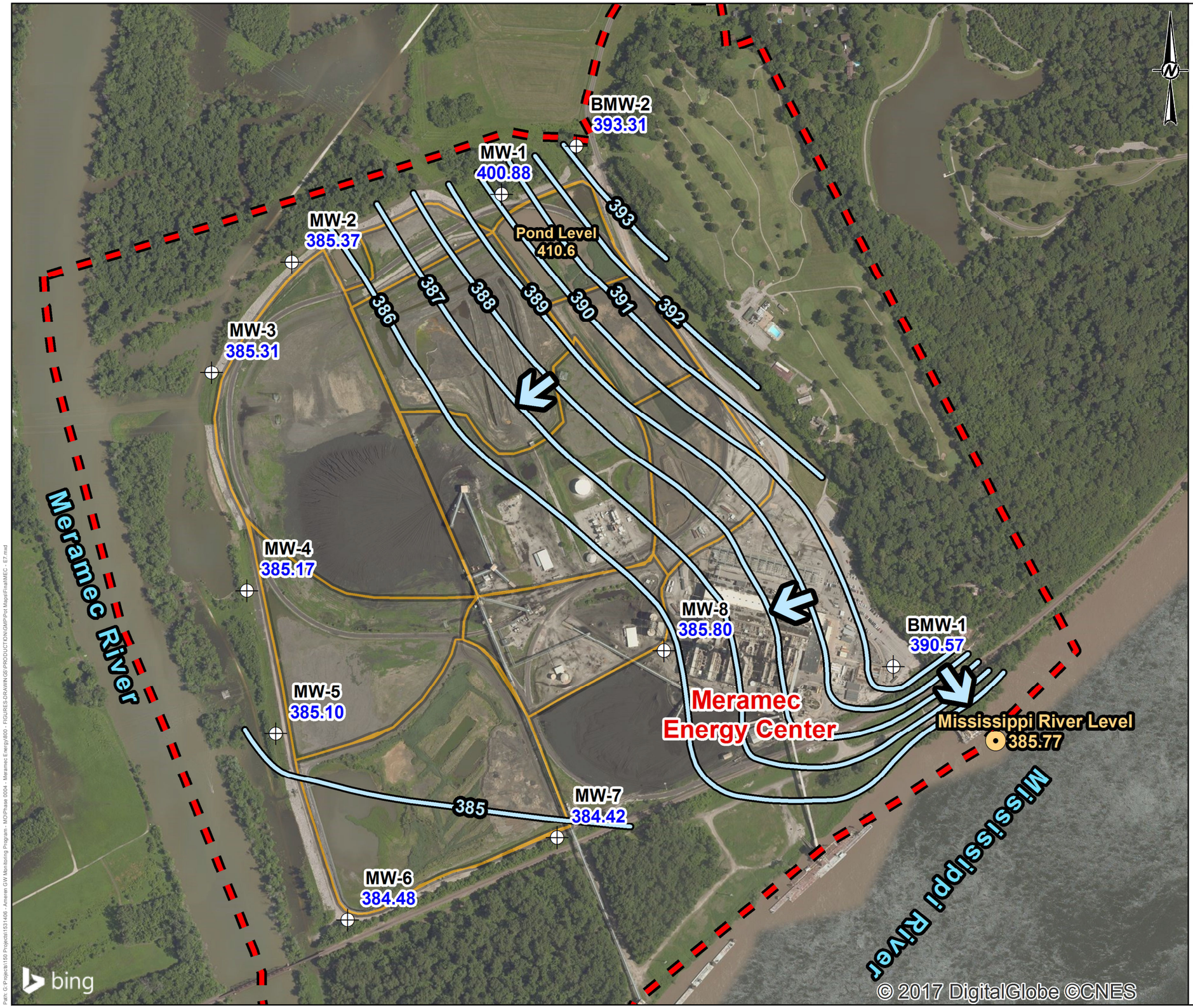

LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
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5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

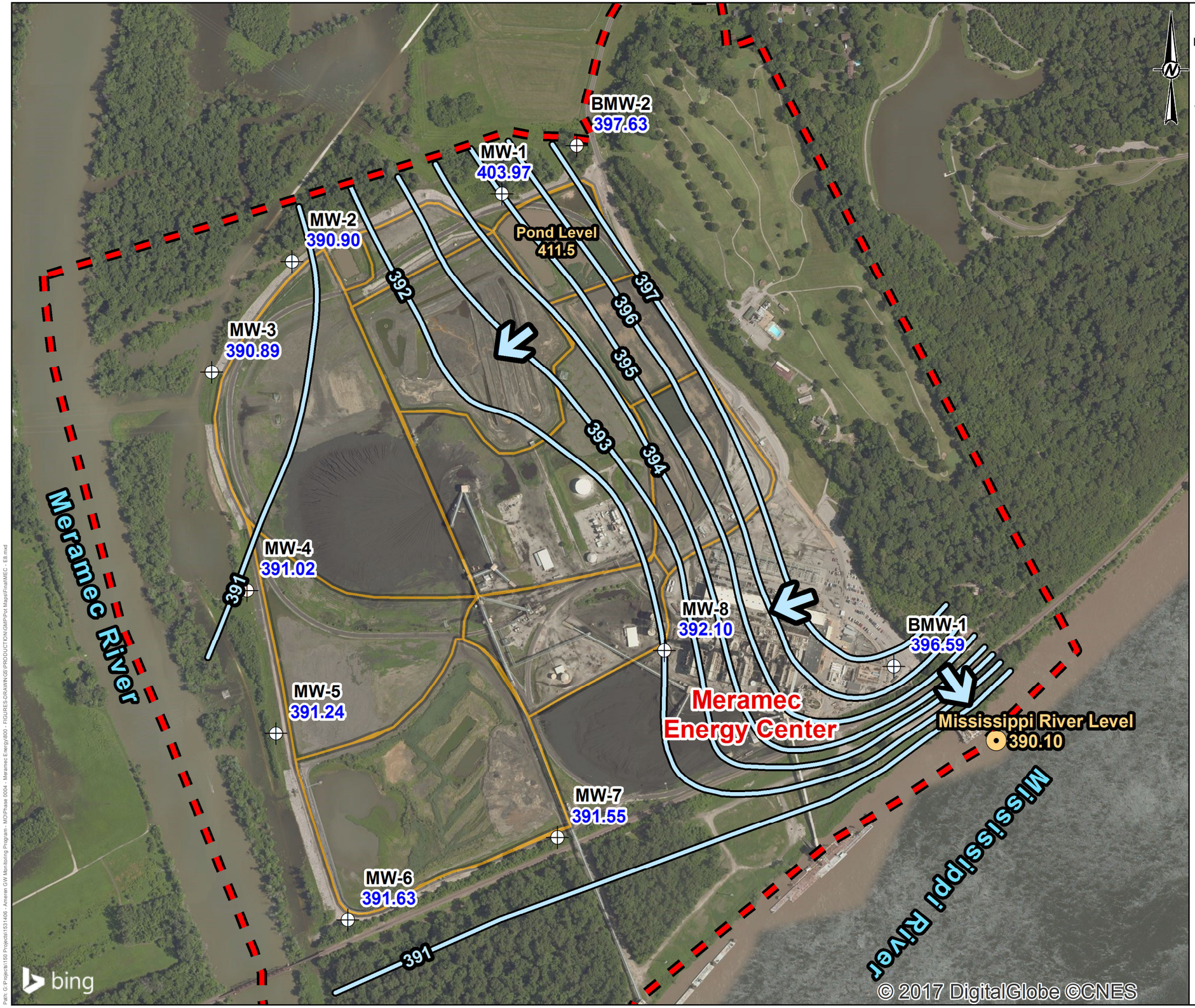
PROJECT
CCR GROUNDWATER MONITORING PROGRAM

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

CONSULTANT
Golder Associates

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

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P7**



LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction

KEY MAP

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 FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
CCR GROUNDWATER MONITORING PROGRAM

TITLE
POTENTIOMETRIC SURFACE MAP
BACKGROUND EVENT 8 - JUNE 14, 2017

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-07-06
PREPARED	JS
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No. 153-1406 | PHASE 0004A | Rev. 0.0 | FIGURE **P8**

AMEREN_00000708

Path: G:\Projects\153\Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0004 - Meramec Energy\800 - FIGURES-DRAWINGS\PRODUCTION\GMP\Pot Maps\FinalMEC - E8.mxd

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

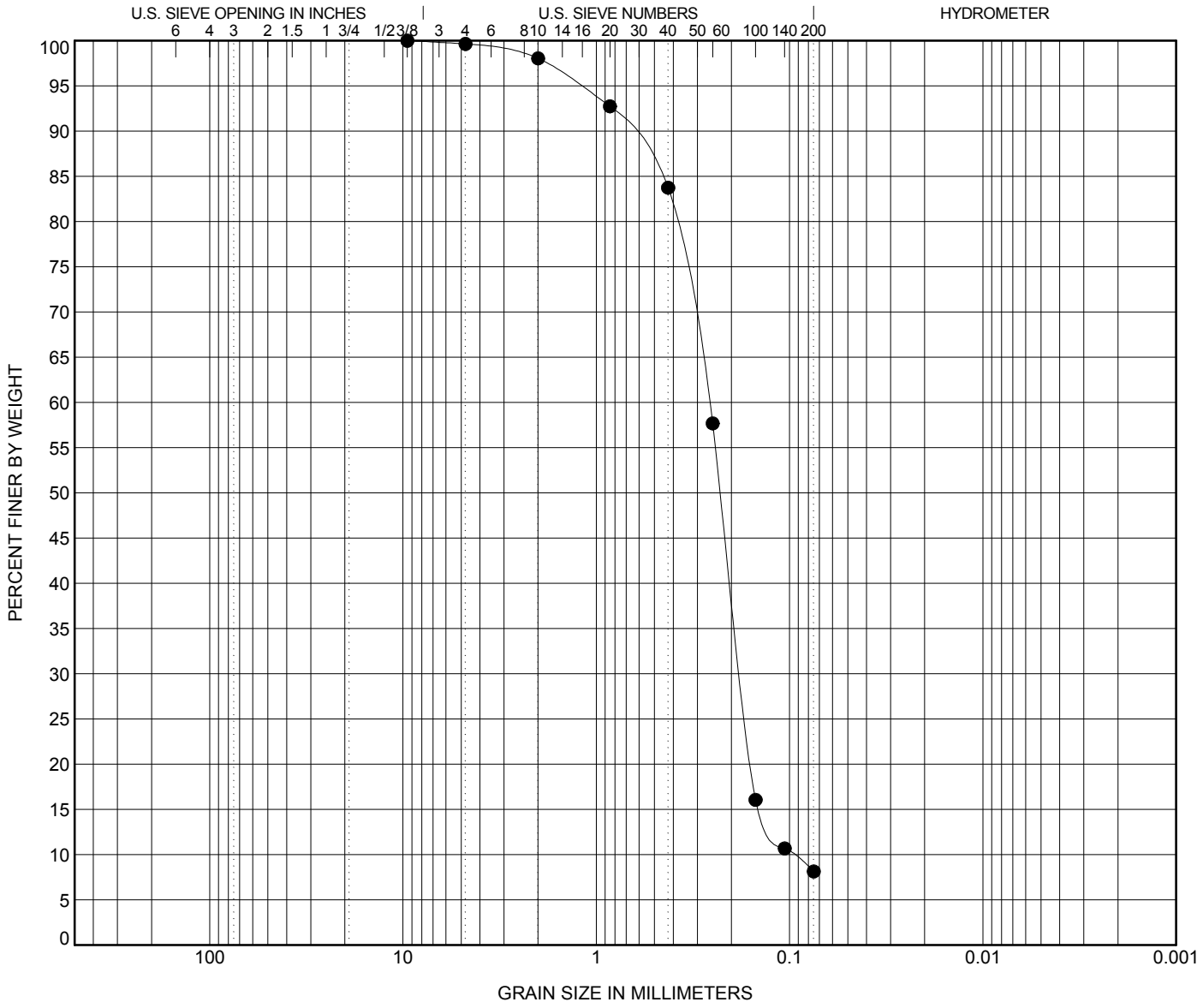
APPENDIX G
GRAIN SIZE DISTRUBUTION

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

GRAIN SIZE DISTRIBUTION
ASTM D6913

CLIENT Ameren Services **PROJECT NAME** Ameren/GW Monitoring Program/MO

PROJECT NUMBER 1531406 **PROJECT LOCATION** Missouri



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	Method	Proced.	Comp. Sieve?	Separ. Sieve	Soak Time	Prior Test.?	Test Date	Description	Tech.	Review	Notes
●	MW-6	45-55 ft		B	Moist	No		1 hr.	No	3/4/16		MR	VK	

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MW-6	45-55 ft	9.5	0.262	0.178	0.097	0.4	91.5	8	

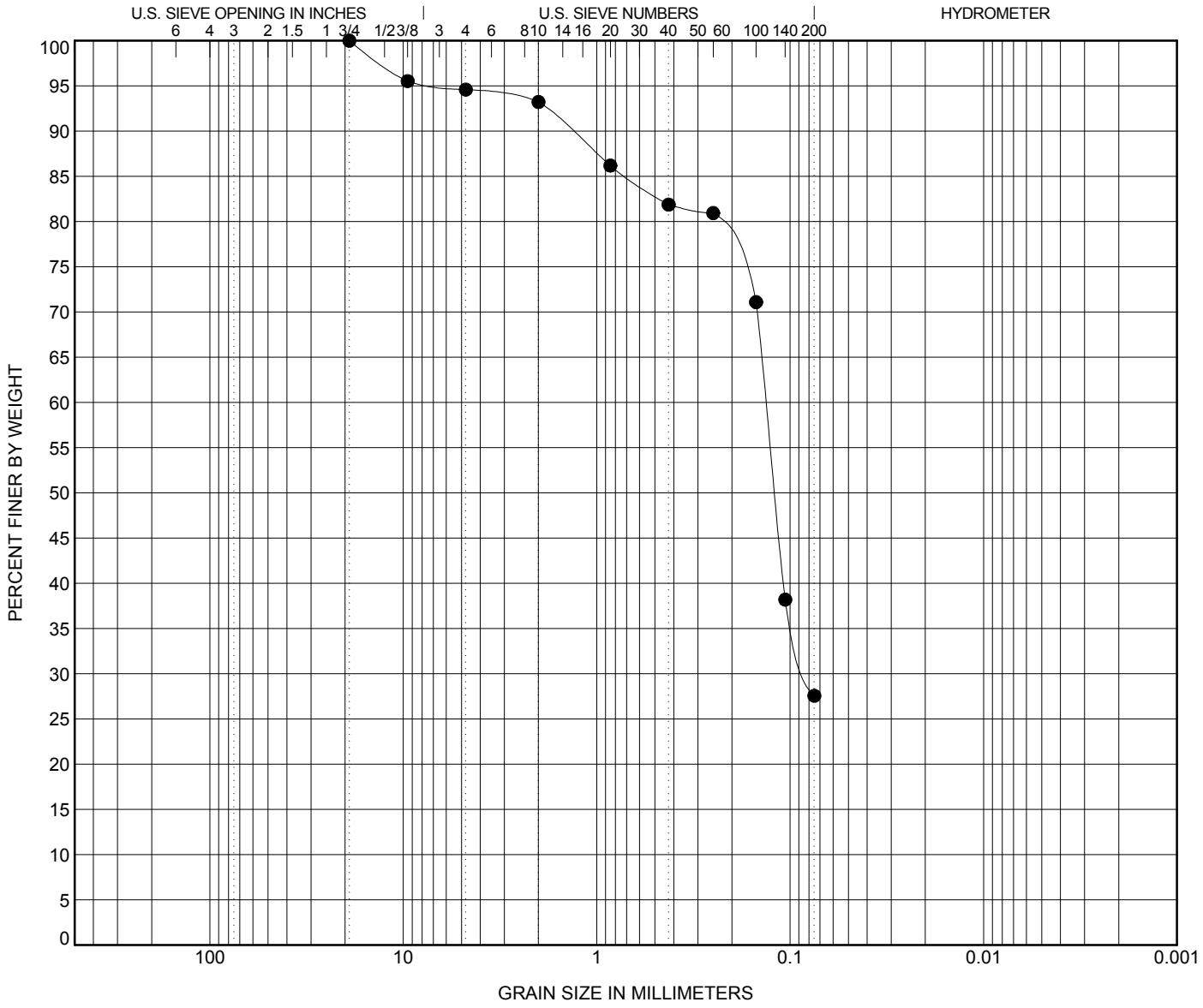
SIEVE_2016 (FEET) - GINT STD US LAB.GDT - 3/4/16 13:40 - L:\16 - 2016 FILE FOLDERS\1531406.0004_AMEREN GW\15631406_AMEREN GW.GPJ

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

GRAIN SIZE DISTRIBUTION
ASTM D6913

CLIENT Ameren Services **PROJECT NAME** Ameren/GW Monitoring Program/MO

PROJECT NUMBER 1531406 **PROJECT LOCATION** Missouri



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	Method	Proced.	Comp. Sieve?	Separ. Sieve	Soak Time	Prior Test.?	Test Date	Description	Tech.	Review	Notes
●	MW-8	66-76 ft		B	Moist	No		1 hr.	No	3/4/16		MR	VK	

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MW-8	66-76 ft	19	0.133	0.081		5.4	67.0	28	

SIEVE_2016 (FEET) - GINT STD US LAB.GDT - 3/4/16 13:40 - L:\16 - 2016 FILE FOLDERS\1531406.0004_AMEREN GW\15631406_AMEREN GW.GPJ

APPENDIX H
WELL DEVELOPMENT FORMS

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-1

Monitored By: JS Date 2/5/16 Time 0722

Well Piezometer Data

Depth of Well (from (top of PVC) or ground)	41.25	feet
Depth of Water (from top of PVC or ground)	4.45	feet
Radius of Casing	~~7~~	inches
	2	feet
Casing Volume	~~8.45 · 3 = 25.4~~	cubic feet
	8.45 · 3 = 25.4	gallons

+125 gal H_2O from drilling

150.4 gal total

Development / Purging Discharge Data

Purging Method: Watera

Start Purging Date 2/5/16 Time 0835

Stop Purging Date 2/5/16 Time 1135

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/5/16	1017	75	13.46	7.20	1.065	126	1.02	-62.7	4.63	Remove surge block, cloudy
	1030	95	13.88	7.61	1.062	28.8	0.86	-73.8	4.78	clear
	1045	115	13.~~87~~	7.46	1.057	13.8	0.82	-78.0	4.67	clear
	1100	135	13.79	7.39	1.057	9.11	0.76	-79.1	4.75	clear
	1115	155	13.78	7.35	1.061	7.37	0.83	-83.1	4.79	clear
	1130	175	13.88	7.32	1.062	7.43	0.81	-77.5	4.~~78~~	clear

TD post Dev't - 41.36

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-2

Monitored By: JS Date 2/1/16 Time 0840

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	36.75 / Final TD 36.84	feet
Depth of Water (from top of PVC or ground)	13.92	feet
Radius of Casing	2	inches
	—	feet
Casing Volume	8.3 = 24	cubic feet
		gallons

+150 gal H_2O from drilling
175 gal total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/1/16 Time 0930

Stop Purging Date 2/1/16 Time 1440

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°C)	pH	Spec.Cond. (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/1/16	1202	60	–	–	–	–	–	–	13.98	Remove surge block
	1222	70	14.04	9.01	1.142	85.4	5.01	-93.8	13.95	Cloudy
	1240	80	13.75	8.80	1.144	14.5	0.86	-128.1	14.09	clear
	1300	110	13.82	8.74	1.145	8.30	0.69	-120.9	14.11	clear
	1315	125	13.89	8.50	1.145	7.96	0.64	-127.4	14.13	Clear
	1330	140	13.85	8.34	1.146	6.81	0.66	-101.9	14.12	clear
	1345	155	13.72	8.21	1.149	6.97	0.56	-86.2	14.14	clear
	1400	170	13.78	8.00	1.151	6.85	0.65	-123.3	14.13	Clear
	1415	185	13.69	7.85	1.148	5.96	0.71	-117.4	14.13	Clear
	1430	200	13.80	7.84	1.150	6.81	0.73	-109.9	14.12	clear
	1440	210	13.87	7.79	1.149	6.61	0.78	-110.1	14.12	clear

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-3

Monitored By: JS Date 2/4/16 Time 0744

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	33.03	feet
Depth of Water (from top of PVC or ground)	12.08	feet
Radius of Casing	2	inches
	~~—~~	feet
Casing Volume	~~—~~	cubic feet
	5.703 = 17.1	gallons

+ 150 gal H_2O from drilling
= 168 gal H_2O

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/4/16 Time 0802

Stop Purging Date 2/4/16 Time 1330

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/4/16	0935	75	12.26	7.12	1.144	71000	1.65	12.1	12.10	slightly muddy
	1030	83	11.39	6.95	1.152	71000	0.54	-53.4	12.00	very muddy
	1045	90	11.90	6.95	1.160	71000	0.62	-58.6	12.01	very muddy
	1100	97	12.21	6.86	1.148	71000	0.68	-45.1	12.09	muddy
	1115	120	13.02	6.75	1.148	141	0.72	-40.0	12.06	cloudy
	1130	129	13.20	6.73	1.156	71000	4.06	-38.7	12.02	Remove Surge block, muddy
	1145	155	12.33	6.69	1.155	71000	1.23	-31.7	12.00	slightly muddy
	1200	165	12.80	6.78	1.154	239	1.05	-53.4	12.01	slightly muddy
	1225	175	12.95	6.69	1.158	58.4	0.85	-57.3	11.96	cloudy
	1240	190	13.66	6.67	1.150	291	0.62	-62.7	12.01	very cloudy
	1255	205	13.43	6.64	1.152	25.0	0.70	-69.3	11.91	clear
	1310	215	13.80	6.71	1.154	9.93	0.73	-68.1	11.90	clear
	1325	225	13.80	6.70	1.152	8.15	0.68	-65.6	11.86	clear

post dev't TD: 33.09

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-4

Monitored By: JS Date 2/8/16 Time 0729

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	45.25	feet
Depth of Water (from top of PVC or ground)	17.94	feet
Radius of Casing	2	inches
	—	feet
Casing Volume	—	cubic feet
	7 • 3 = 21 gal	gallons

+200 gal H_2O from drilling
= 221 gal H_2O total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/8/16 Time 0828

Stop Purging Date 2/8/16 Time ~~0700~~ 1650

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/8/16	1021	85	13.11	7.66	1.320	71000	0.99	-69.6	18.20	muddy
	0836	90	11.36	7.61	1.318	71000	1.54	-84.2	18.36	muddy
	1050	~~90~~ 95	5.86	7.41	1.312	71000	2.04	-73.3	18.82	muddy
	1105	97	6.68	7.27	1.307	71000	1.57	-48.2	18.39	muddy
	1120	98	11.75	7.36	1.327	71000	2.08	-69.0	18.40	muddy
	1135	103	11.32	7.18	1.334	71000	3.20	-46.4	18.36	slightly muddy, Remove Surge block
	1150	120	11.46	7.30	1.342	124	1.93	-62.8	18.37	very cloudy
	1210	165	11.03	7.08	1.340	139	1.50	-61.2	18.40	very cloudy
	1225	190	11.47	7.24	1.323	104	1.24	-69.0	18.40	cloudy, dump purge water
	1310	193	4.29	6.99	1.327	124	1.98	-36.4	17.98	cloudy
	1330	220	9.64	7.29	1.333	217	1.73	-51.0	18.16	very cloudy
	1345	230	9.56	7.29	1.316	—	0.86	-59.1	18.21	very cloudy
	1400	245	10.34	7.25	1.316	163	0.91	-72.2	18.25	very cloudy, low flow
	1415	255	10.28	7.23	1.325	51.1	0.66	-73.7	18.24	cloudy
	1430	270	9.20	7.18	1.354	48.6	1.13	-76.5	18.26	slightly cloudy
	1456	275	2.82	7.20	1.342	42.4	2.53	-44.5	18.19	slightly cloudy
	1515	279	6.25	7.20	1.340	70.2	2.01	-59.2	18.25	slightly cloudy
	1530	290	9.50	7.19	1.338	30.8	0.63	-68.4	18.27	clear
	1545	300	9.98	7.26	1.327	48.5	1.02	-71.2	18.28	slightly cloudy
	1600	307	10.05	7.24	1.332	64.1	0.76	-71.5	18.31	slightly cloudy
	1615	317	9.68	7.25	1.340	70.5	1.06	-79.0	18.32	cloudy
	1630	335	9.41	7.24	1.320	38.0	1.30	-73.5	18.35	slightly cloudy
	1645	345	8.66	7.24	1.325	24.5	1.35	-71.4	18.36	clear
	1650	350	8.43	7.24	1.328	23.6	1.18	-69.2	18.36	clear

post Dev't TD: 45.17

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-5

Monitored By: ~~ES~~ Date 2/9/16 Time 0800

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	62.70	feet
Depth of Water (from top of PVC or ground)	17.98	feet
Radius of Casing	2	inches
	~~feet~~	feet
Casing Volume	~~cubic feet~~	cubic feet
	11.23	gallons ~250 gal H_2O from drilling

284 gal total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/9/16 Time 0840

Stop Purging Date 2/9/16 Time 1240

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/9/16	0945	160	13.18	8.77	1.270	71000	0.64	-105.6	18.89	muddy
	1000	195	13.21	8.51	1.263	39.2	1.12	-109.4	18.61	slightly cloudy, trace sediment black
	1010	225	13.40	8.28	1.270	21.8	0.92	-124.8	18.60	clear
	1045	240	12.18	8.44	1.297	78.1	1.08	-124.7	18.45	cloudy
	1055	260	12.91	8.60	1.267	76.7	0.82	-125.8	18.45	cloudy
	1105	285	13.23	8.32	1.272	43.7	0.76	-130.9	18.45	slightly cloudy
	1115	300	12.40	8.13	1.261	55.3	1.33	-124.4	18.29	slight cloudy
	1125	303	12.50	8.01	1.265	52.8	1.28	-108.6	18.29	slightly cloudy, low flow
	1135	306	12.38	8.03	1.270	25.0	1.27	-103.7	18.26	clear
	1145	310	12.55	7.90	1.266	20.0	1.26	-92.2	18.25	clear
	1205	320	12.31	7.38	1.268	14.4	1.13	-86.2	18.29	clear
	1215	325	12.36	7.37	1.270	14.4	1.10	-84.9	18.30	clear
	1225	330	12.33	7.38	1.273	13.5	1.08	-91.1	18.29	clear
	1235	337	12.41	7.37	1.277	13.0	1.05	-89.4	18.29	clear

post Dev't TD: 62.72

* D.I. water reads 8.07

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-6

Monitored By: JS Date 2/3/16 Time 1308

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	55.42	feet
Depth of Water (from top of PVC or ground)	33.36	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	7.3 · 3 = 21.9	gallons

+300 gal H_2O from drilling

322 gal total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/3/16 Time 1322

Stop Purging Date 2/3/16 Time 1630

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/3/16	1340	50	13.45	7.58	1.474	71000	1.48	-41.2	34.39	muddy
	1355	95	14.46	7.24	1.607	71000	1.13	-54.2	34.30	muddy
	1410	130	13.80	7.08	1.666	71000	1.30	-47.5	34.19	muddy
	1425	175	14.30	7.07	1.690	71000	1.61	-50.7	34.02	muddy
	1440	220	14.10	6.96	1.686	74.1	1.22	-50.1	34.41	cloudy
	1515	255	14.08	7.06	1.723	48.7	1.87	-63.7	34.20	cloudy, removed surge block
	1520	305	14.42	7.03	1.693	13.9	1.27	-60.3	34.17	clear
	1540	335	14.06	6.98	1.688	1.5	1.33	-43.6	33.56	clear, low flow
	1550	346	13.70	6.98	1.702	1.98	1.28	-40.9	33.52	clear
	1600	343	13.47	6.99	1.701	19.5	1.23	-46.1	33.50	clear
	1610	352	13.71	6.96	1.699	15.4	1.08	-42.4	33.51	clear
	1620	360	13.75	6.99	1.699	14.1	1.26	-49.1	33.46	clear
	1630	367	13.77	6.99	1.699	13.4	1.23	-49.3	33.44	clear

post TD: 55.45

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-7

Monitored By: JS Date 1/29/16 Time 1028

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	53.13	feet
Depth of Water (from top of PVC or ground)	31.66	feet
Radius of Casing	2	inches
		feet
Casing Volume	7.4.3 = 22.3	cubic feet
		gallons

+200 gal H_2O used
Total 222.5

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 1/29/16 Time 1026

Stop Purging Date 1/29/16 Time 1517

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
1/29/16	1037	38	14.60	9.16	1.462	>1000	1.31	-262.3	32.11	muddy
	1050	75	15.00	8.81	1.706	>1000	1.61	-260.2	32.05	muddy
	1105	92	14.86	8.70	1.848	>1000	1.50	-260.1	31.92	muddy
	1120	167	14.65	8.32	1.851	>1000	1.42	-264.1	31.69	muddy
	1138	125	14.90	8.06	2.004	>1000	1.06	-225.4	32.20	muddy, surge block removed
	1155	175	14.95	7.73	2.083	17.6	0.89	-267.1	32.21	clear
	1210	—	—	—	—	—	—	—	—	pause devlt
	1305	175	14.25	8.50	2.148	33.3	2.81	-224.4	31.81	clear, resume purge
	1325	215	14.74	8.10	2.182	12.4	1.31	-243.7	32.14	clear
	1335	235	15.12	7.96	2.200	11.3	0.98	-241.1	32.02	clear
	1345	242	15.00	7.72	2.200	12.3	1.01	-256.7	32.05	clear, low flow
	1355	255	15.01	7.67	2.209	10.2	0.92	-209.4	31.90	clear, low flow
	1405	260	15.02	7.71	2.217	10.3	1.14	-227.7	32.07	clear, low flow
	1415	265	15.00	7.84	2.220	8.45	1.03	-241.5	31.90	clear, low flow
	1425	265	14.77	7.74	2.217	7.96	1.32	-241.8	31.81	clear, low flow
	1440	268	14.14	7.33	2.219	9.12	1.61	-200.0	31.80	clear, low flow
	1455	270	14.19	7.11	2.212	9.22	1.26	-165.2	31.78	clear, low flow
	1510	273	14.17	7.17	2.210	9.10	1.30	-197.4	31.75	clear, low flow
	1515	274	14.17	7.14	2.217	9.08	1.18	-183.6	31.73	clear, low flow

post TD= 52.92

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location MW-8b

Monitored By: JS Date 2/3/16 Time 0735

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	78.80	feet
Depth of Water (from top of PVC or ground)	37.78	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	10.5 × 3 = 31.5	gallons

+250 gal H_2O from drilling

282 gal H_2O total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/3/16 Time 0754

Stop Purging Date 2/10/16 Time 1336

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/3/16	0833	90	13.47	8.03	1.181	71000	0.56	-15.4	40.98	very muddy, gray
	0845	110	13.72	7.89	1.183	71000	0.54	-32.6	41.32	very muddy/silty, gray
	0855	145	13.54	7.77	1.191	71000	0.63	-54.9	46.84	very muddy, gray
	0910	175	13.67	7.69	1.189	71000	0.72	-77.1	40.97	very muddy, gray
	0925	210	13.42	7.60	1.191	71000	0.80	-94.6	41.65	very muddy, gray
	0940	235	13.49	7.53	1.194	71000	0.66	-98.1	41.44	Replace surge block, v. muddy ☆
	1005	250	13.55	7.36	1.196	71000	0.67	-100.1	41.19	very muddy, gray
	1020	310	13.16	7.56	1.202	71000	1.23	-89.0	41.20	very muddy, gray
	1035	340	13.24	7.47	1.200	71000	0.90	-93.4	39.41	very muddy, gray
	1050	355	14.07	7.44	1.194	71000	0.70	-93.3	41.14	very muddy, gray
	1105	373	13.65	7.45	1.198	71000	1.00	-96.3	41.00	very muddy, gray
	1120	415	13.40	7.38	1.196	71000	0.69	-89.2	41.09	very muddy, gray
	1145	435	11.43	7.37	1.196	71000	0.72	-90.4	38.46	very muddy, gray, low flow
	1200	440	10.33	7.42	1.142	71000	0.65	-86.6	38.39	very muddy, dark gray
	1215	443	10.12	7.46	1.168	71000	1.77	-87.8	38.40	very muddy, dark gray
2/4/16	1539	443	—	—	—	—	—	—	17.10	TD: 78.25, start purge
2/4/16	1616	448	—	—	—	—	—	—	17.36	TD: 77.77, finish purge
2/10/16	1110	448	—	—	—	71000	—	—	38.20	Start purge
2/10/16	1336	530	—	—	—	71000	—	—	39.19	finish purge, TD: 71.66

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location BMW-26

Monitored By: SS Date 2/5/16 Time 1247

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	43.99	feet
Depth of Water (from top of PVC or ground)	13.99	feet
Radius of Casing	2	inches
	—	feet
Casing Volume	—	cubic feet
	7.3 · 3 = 21.9	gallons

+120 gal H_2O from drilling

142 gal H_2O to Eq

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 2/5/16 Time 1300

Stop Purging Date 2/5/16 Time 1544

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
2/5/16	1320	30	13.48	7.59	0.877	71000	0.81	-49.2	14.66	muddy
	1335	45	13.59	7.43	0.876	71000	0.64	-50.8	14.80	muddy
	1350	60	13.41	7.49	0.816	71000	0.83	-75.4	14.92	muddy
	1405	75	13.40	7.46	0.834	71000	0.80	-68.0	14.79	muddy
	1420	90	13.32	7.41	0.839	294	0.78	-53.6	14.99	clear
	1435	105	13.02	7.60	0.841	237	0.97	-59.3	14.89	clear
	1450	120	13.12	7.52	0.841	27.5	0.89	-63.3	14.91	clear
	1505	135	12.87	7.44	0.857	34.7	0.92	-65.9	15.50	Remove surge block ★, clear
	1520	150	13.50	7.41	0.863	16.0	0.96	-60.4	15.60	clear
	1535	165	13.32	7.35	0.870	13.1	0.97	-58.4	15.59	clear

Post Dev't TD: ~~44.50~~ 44.00

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location BMW-1a

Monitored By: JS Date 4/8/16 Time 0900

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	62.90	feet
Depth of Water (from top of PVC or ground)	25.23	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
	10.4 · 3 = 31.2	gallons

+200 gallons from drilling

232 gal total

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 4/8/16 Time 0931

Stop Purging Date 4/8/16 Time 1630

Monitoring

Q (L/min)

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
	0953	5	12.58	7.26	1.468	71000	5.54	212.0	39.30	Very muddy / gray, Q: 1 L/min
	0943	8	13.24	7.05	1.521	71000	4.49	63.2	32.52	" " " " Q: 1 L/min
	0953	10	13.42	6.96	1.521	71000	4.07	8.5	32.59	" " " Q: 1 L/min
	003	12	13.04	7.00	1.540	71000	3.79	-20.0	32.67	" " " Q: 0.9 L/min
	1013	15	14.14	6.99	1.552	71000	2.87	-26.1	31.46	" " " Q: 1 L/min
	1033	20	13.68	6.33	1.616	71000	3.61	9.6	35.95	" " " Q: 2 L/min
	1053	30	14.47	6.83	1.657	71000	2.32	-29.6	35.10	muddy / gray, Q: 2 L/min
	1113	40	14.17	6.92	1.665	71000	2.35	-37.8	44.93	muddy / gray, Q: 2.4
	1133	58	14.33	6.23	1.627	71000	2.31	9.1	44.52	muddy / gray, Q = 2.4
	1153	75	12.77	6.94	1.729	71000	2.17	-12.6	46.63	muddy / gray, Q = 3.0
	1213	95	15.18	6.34	1.629	71000	1.81	-45.2	46.95	muddy / gray, Q = 3.0
	1293	110	13.74	7.11	1.645	71000	3.12	-43.8	38.11	Remove surge block, Q = 5.0
	1306	130	14.04	6.93	1.700	948	4.14	-29.4	58.32	~~sl~~ cloudy Q = 5.0
	1320	140	14.90	6.56	1.678	659	2.43	-15.9	42.72	cloudy Q = 2.5
	1335	150	15.20	6.54	1.668	614	3.08	-34.7	39.34	cloudy Q = 3.0
	1355	167	15.17	6.46	1.662	790	1.12	-16.4	45.19	cloudy Q = 3.0
	1415	186	15.06	6.84	1.686	836	1.75	-30.4	49.52	cloudy Q = 3.0
	1435	205	13.41	6.83	1.740	71000	2.11	-39.4	50.11	cloudy / gray Q = 4.0
	1525	230	14.60	6.52	1.725	71000	1.47	-11.9	51.13	cloudy / gray, Q = 3.0
	1540	245	15.76	6.83	1.711	71000	1.10	-42.4	47.0	cloudy / ~~rusty~~, Q = 3.0
	1555	263	14.39	6.62	1.730	71000	1.42	-28.5	47.52	cloudy / gray, Q = 3.0
	1610	280	15.25	6.59	1.697	71000	1.13	-27.8	47.65	cloudy / gray, Q = 3.0
	1625	—	—	—	—	—	—	—	—	pause purge

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location BMW-1a

Monitored By: JS Date 4/13/16 Time 0820

Well Piezometer Data

(circle one)

Depth of Well (from top of PVC or ground)	62.90	feet
Depth of Water (from top of PVC or ground)	24.74	feet
Radius of Casing	2	inches
		feet
Casing Volume		cubic feet
		gallons

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 4/14/16 Time 0838

Stop Purging Date Time

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
4/14/16	0840	5	15.87	6.52	1.493	71000	1.98	159.3	34.15	muddy
	0850	20	16.36	6.95	1.504	71000	0.90	17.3	43.90	muddy
	0900	37	16.45	6.97	1.504	71000	0.97	-28.0	47.10	muddy
	0910	46	16.53	6.97	1.503	71000	1.30	-46.8	48.79	muddy
	0920	60	16.57	6.94	1.513	71000	1.05	-55.1	54.01	muddy
	0930	80	16.51	6.92	1.528	71000	1.80	-50.2	55.41	muddy
	0940	96	16.36	6.93	1.551	71000	1.70	-49.7	55.95	muddy
	0950	107	16.23	6.85	1.593	71000	1.78	-42.4	56.40	muddy
	1000	125	16.15	6.90	1.604	71000	1.19	-44.7	57.11	muddy
	1010	145	15.99	6.73	1.657	71000	2.37	-34.1	60.44	muddy purged dry
	1108	155	17.26	7.13	1.635	172	2.61	-52.1	36.81	cloudy
	1118	165	17.28	7.12	1.683	729	2.25	-62.7	57.51	muddy
	1128	185	16.99	6.99	1.692	70.3	1.57	-51.1	61.00	slightly cloudy
	1138	190	—	—	—	—	—	—	61.40	Stop purge, dry
	1156	195	17.13	7.24	1.780	71000	1.44	-20.0	35.42	muddy/sandy
	1206	215	17.07	6.86	1.711	70.5	1.42	-48.9	50.15	cloudy
	1216	230	16.92	6.89	1.706	114	1.37	-53.7	51.62	cloudy
	1226	255	16.86	6.79	1.701	169	1.23	-50.9	52.81	cloudy
	1236	265	16.79	6.83	1.715	184	1.61	-52.7	48.61	cloudy
	1250	280	16.74	6.80	1.723	226	1.51	-50.3	57.95	cloudy
	1305	290	—	—	—	—	—	—	60.14	purged dry
	1338	295	16.75	7.11	1.588	45.8	4.96	-4.3	33.47	cloudy
	1348	300	17.03	6.86	1.679	303	2.94	-26.9	34.40	cloudy
	1358	305	17.01	6.93	1.690	236	2.88	-40.8	35.75	cloudy
	1408	309	17.02	6.96	1.697	176	2.27	-48.5	36.24	cloudy
	1418	313	17.04	6.99	1.700	138	2.27	-54.5	36.56	cloudy
	1428	317	17.04	6.99	1.702	130	2.01	-44.8	37.10	cloudy

Golder Associates WELL DEVELOPMENT/PURGING FORM

Project Ref: Ameren GW Monitoring **Project No.:** 153-1406.0004

Location BMW-1a

Monitored By: JS Date 4/13/16 Time 1421

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

See page 1

Development / Purging Discharge Data

Purging Method: Waterra

Start Purging Date 4/13/16 Time 0838

Stop Purging Date Time 1603

Monitoring

Date	Time	Volume Discharge (gals)	Temp (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft BTOC)	Appearance of Water and Comments
4/13/16	1448	320	17.07	6.96	1.705	126	1.66	-57.6	37.15	cloudy
	1508	325	17.04	6.95	1.701	115	1.43	-57.3	36.75	cloudy
	1528	330	17.00	6.91	1.701	150	1.31	-57.0	36.92	cloudy
	1548	335	17.00	6.89	1.698	151	1.41	-56.8	36.81	cloudy

APPENDIX I
CCR MDNR WELL CERTIFICATION FORMS

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00304699	03/14/2016
CR NO	CHECK NO.
	170083
STATE WELL NO	REVENUE NO.
A206420 03/15/2016	031416
ENTERED NRBASSM	APPROVED BY / ROUTE
PH1 PH2 PH3	
03/14/2016 03/14/2016 03/14/2016	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI C/O BILL KUTOSKY	AMEREN MISSOURI C/O BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3750 S LINDEBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
MERAMEC ENERGY CENTER		MW1		ST LOUIS CITY
SITE ADDRESS		CITY		STATIC WATER LEVEL
8200 FINE ROAD		ST LOUIS		4.6 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

LOCATION OF WELL

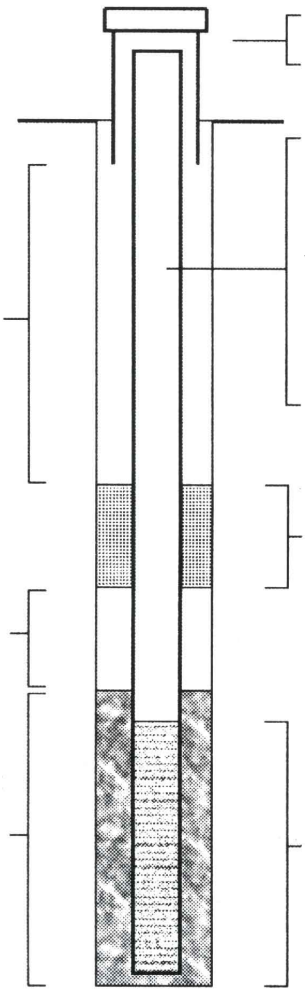
LAT. 38 ° 24' 31.23"
LONG. 90 ° 20' 25.26"

SMALLEST _____ 1/4 _____ 1/4 _____ 1/4 LARGEST

SEC. LG000050 TWN. _____ NORTH
RANGE _____ Direction E

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [X] PETROLEUM PRODUCTS ONLY
- [X] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE



- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION _____FT.

ANNULAR SEAL
LENGTH 0.0FT.
- [ ] SLURRY
- [ ] PELLETS
- [X] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.5FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 32.4FT.

LENGTH OF PRIMARY FILTER PACK: 7.6FT.

SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
- RISER PIPE DIAMETER 2.0IN.
- RISER PIPE LENGTH 36.2FT.
- HOLE DIAMETER 6.0IN.
- WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 27.5
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
- SCREEN DIAMETER: 2.0IN.
- SCREEN LENGTH: 4.8FT.
- DIAMETER OF DRILL HOLE: 6.0IN.
- DEPTH TO TOP 35.2FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	10.0	SLT
10.0	15.0	CLY SLT
15.0	21.4	SILT
21.4	32.7	SLT
32.7	36.2	SLT SND
36.2	40.0	SDY GRVL
		TOTAL DEPTH: 40.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JOHN SUOZZI	006284	01/23/2016

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

- [ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304700	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206421 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/14/2016 03/14/2016	APPROVED BY
	ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER MW2	COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS	STATIC WATER LEVEL 15.1 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 24' 27.77"
LONG. 90 ° 20' 38.95"

SMALLEST _____ 1/4 _____ 1/4 LARGEST _____ 1/4

SEC. LG003051 TWN. _____ NORTH
RANGE _____ Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [X] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [X] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

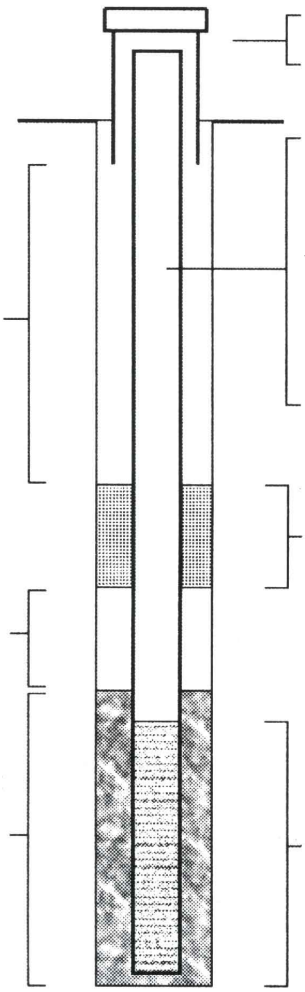
ANNULAR SEAL
LENGTH 0.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 1.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 37.7FT.

LENGTH OF PRIMARY FILTER PACK: 7.3FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 31.6FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 23.5
[ ] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 4.8FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 40.2FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	12.4	SLT
12.4	30.0	STY CLY
30.0	31.2	SND
31.2	34.2	STY CLY
34.2	34.6	STY GRVL
34.6	45.0	STY CLY
TOTAL DEPTH:		45.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/23/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304701	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206422 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/14/2016 03/14/2016	APPROVED BY
ROUTE	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER MW3	COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS	STATIC WATER LEVEL 13.6 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

LOCATION OF WELL

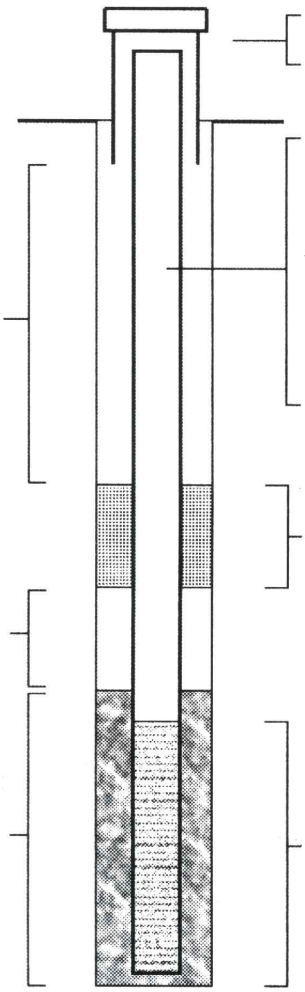
LAT. 38 ° 24' 7.2"
LONG. 90 ° 20' 44.21"

SMALLEST 1/4 1/4 LARGEST 1/4

SEC. LG003052 TWN. NORTH
RANGE Direction

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [X] PETROLEUM PRODUCTS ONLY
- [X] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE



- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION FT.

ANNULAR SEAL
LENGTH 0.0FT.
- [ ] SLURRY
- [ ] PELLETS
- [ ] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.5FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 47.4FT.

LENGTH OF PRIMARY FILTER PACK: 7.6FT.

SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
- RISER PIPE DIAMETER 2.0IN.
- RISER PIPE LENGTH 27.9FT.
- HOLE DIAMETER 6.0IN.
- WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 20.0
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
- SCREEN DIAMETER: 2.0IN.
- SCREEN LENGTH: 4.8FT.
- DIAMETER OF DRILL HOLE: 6.0IN.
- DEPTH TO TOP 50.2FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	5.0	SLT
5.0	6.4	CLY SLT
6.4	11.1	STY SND
11.1	13.5	CLY SLT
13.5	22.2	STY CLY
22.2	25.0	CLY SLT
25.0	25.2	SND
25.2	26.1	STY CLY
26.1	30.0	SDY GRVL
30.0	55.0	STY CLY
TOTAL DEPTH:		55.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/22/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x
APPRENTICE PERMIT NUMBER		

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304702	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206423 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/14/2016 03/14/2016	APPROVED BY
	ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY			VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127	
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER MW4		COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS		STATIC WATER LEVEL 20.25 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

LOCATION OF WELL

LAT. 38 ° 24' 10.9"
LONG. 90 ° 20' 41.94"

SMALLEST ____ 1/4 ____ 1/4 ____ 1/4 LARGEST

SEC. LG003051 TWN. ____ NORTH
RANGE ____ Direction E

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [X] PETROLEUM PRODUCTS ONLY
- [X] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE

- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION ____ FT.

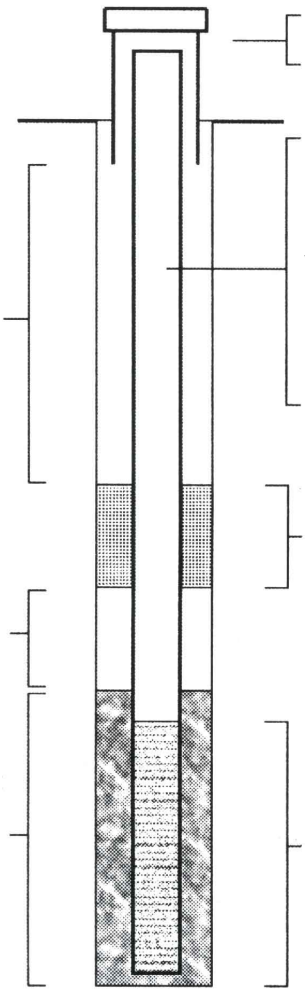
ANNULAR SEAL
LENGTH 0.0 FT.
- [ ] SLURRY
- [ ] PELLETS
- [ ] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 1.7 FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 57.6 FT.

LENGTH OF PRIMARY FILTER PACK: 7.4 FT.



SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
- RISER PIPE DIAMETER 2.0 IN.
- RISER PIPE LENGTH 40.0 FT.
- HOLE DIAMETER 6.0 IN.
- WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 31.5
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
- SCREEN DIAMETER: 2.0 IN.
- SCREEN LENGTH: 4.8 FT.
- DIAMETER OF DRILL HOLE: 6.0 IN.
- DEPTH TO TOP 60.2 FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	12.4	CLY SLT
12.4	15.0	CLY SLT
15.0	20.0	STY CLY
20.0	40.0	CLY SLT
40.0	41.3	GRVL
41.3	60.0	STY CLY
60.0	65.0	SLT

TOTAL DEPTH: 65.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/22/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x ____ / APPRENTICE PERMIT NUMBER ____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304703	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206424 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/14/2016 03/14/2016	APPROVED BY
ROUTE	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY		VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER MW5	COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS	STATIC WATER LEVEL 18.4 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

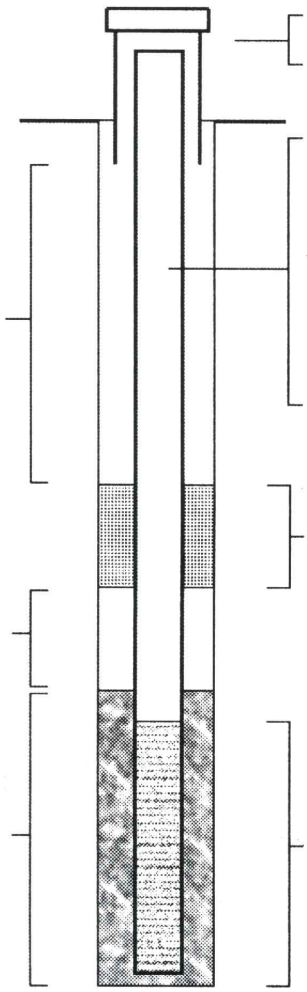
LAT. 38 ° 24' 3.54"
LONG. 90 ° 20' 40.05"

SMALLEST _____ 1/4 _____ 1/4 _____ 1/4 LARGEST

SEC. LG003051 TWN. _____ NORTH
RANGE _____ Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [X] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [X] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH



[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

ANNULAR SEAL
LENGTH 0.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 1.5FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 46.9FT.

LENGTH OF PRIMARY FILTER PACK: 13.1FT.

SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 52.5FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 43.5
[ ] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 9.8FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 50.2FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	10.0	STY CLY
10.0	20.0	CLY SLT
20.0	30.0	STY CLY
30.0	31.9	SND
31.9	35.0	CLY SND
35.0	46.0	STY CLY
46.0	60.0	SND

TOTAL DEPTH: 60.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/22/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____	APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00304704	03/14/2016
CR NO	CHECK NO.
	170083
STATE WELL NO	REVENUE NO.
A206425 03/15/2016	031416
ENTERED NRBASSM	APPROVED BY / ROUTE
PH1 PH2 PH3	
03/14/2016 03/14/2016 03/14/2016	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI C/O BILL KUTOSKY	AMEREN MISSOURI C/O BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3750 S LINDEBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
MERAMEC ENERGY CENTER		MW6		ST LOUIS CITY
SITE ADDRESS		CITY		STATIC WATER LEVEL
8200 FINE ROAD		ST LOUIS		33.6 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

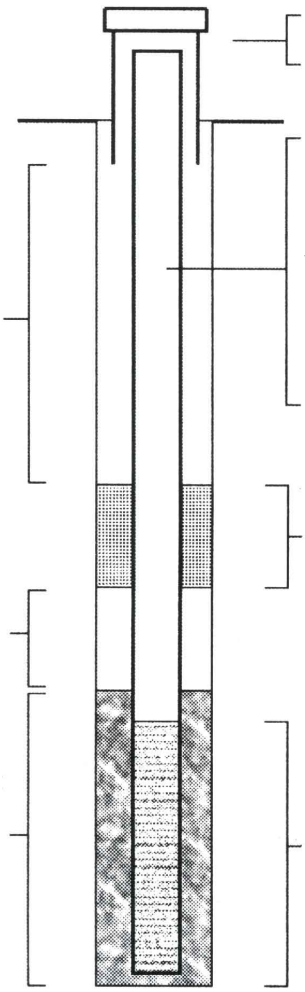
LOCATION OF WELL
- LAT. 38 ° 23' 53.96"
- LONG. 90 ° 20' 35.4"

SMALLEST ____ 1/4 ____ 1/4 ____ 1/4 LARGEST

SEC. LG003051 TWN. ____ NORTH
RANGE ____ Direction E

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [X] PETROLEUM PRODUCTS ONLY
- [X] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE



- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION ____ FT.

ANNULAR SEAL
LENGTH 0.0 FT.
- [ ] SLURRY
- [ ] PELLETS
- [ ] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.7 FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 42.0 FT.

LENGTH OF PRIMARY FILTER PACK: 13.0 FT.

SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
- RISER PIPE DIAMETER 2.0 IN.
- RISER PIPE LENGTH 44.7 FT.
- HOLE DIAMETER 6.0 IN.
- WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 39.2
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
- SCREEN DIAMETER: 2.0 IN.
- SCREEN LENGTH: 9.8 FT.
- DIAMETER OF DRILL HOLE: 6.0 IN.
- DEPTH TO TOP 45.2 FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	12.9	SDY SLT
12.9	30.0	STY CLY
30.0	42.2	SDY SLT
42.2	52.0	SND
52.0	55.0	SND
		TOTAL DEPTH: 55.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JOHN SUOZZI	006284	01/21/2016

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

- [ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304705	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206426 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/14/2016 03/14/2016	APPROVED BY
	ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY			VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127	
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER MW7		COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS		STATIC WATER LEVEL 33.3 FT

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
[X] ABOVE GROUND	LENGTH 5.0 FT.	DIAMETER 12.0 IN.	[X] CONCRETE
[ ] FLUSH MOUNT	DIAMETER 4.0 IN.	LENGTH 2.5 FT.	[ ] OTHER

LOCATION OF WELL

LAT. 38 ° 23' 58.18"
LONG. 90 ° 20' 21.71"

SMALLEST _____ 1/4 _____ 1/4 LARGEST _____ 1/4

SEC. LG003051 TWN. _____ NORTH
RANGE _____ Direction E

MONITORING FOR:
[ ] RADIONUCLIDES [X] PETROLEUM PRODUCTS ONLY
[ ] EXPLOSIVES [X] METALS [ ] VOC
[ ] SVOCS [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
[ ] GAS MIGRATION WELL [X] OBSERVATION
[ ] EXTRACTION WELL [ ] OPEN HOLE
[ ] PIEZOMETERS
[ ] DIRECT PUSH

[ ] LOCKING CAP
[ ] WEEP HOLE

ELEVATION _____FT.

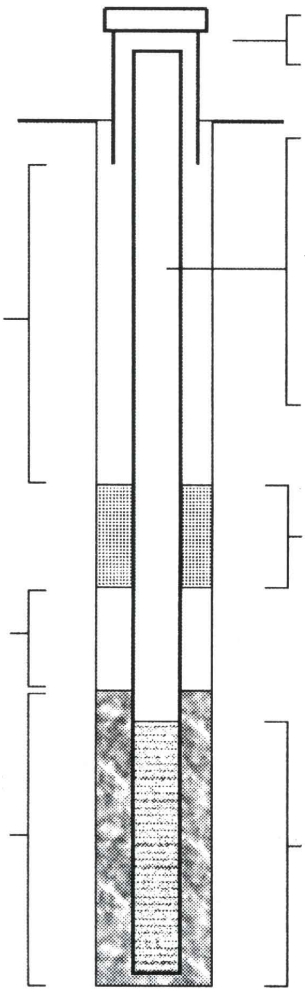
ANNULAR SEAL
LENGTH 0.0FT.
[ ] SLURRY [ ] CHIPS
[ ] PELLETS [ ] GRANULAR
[ ] CEMENT/SLURRY

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 1.5FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 37.8FT.

LENGTH OF PRIMARY FILTER PACK: 14.2FT.



SURFACE COMPLETTION
[ ] STEEL [X] ALUMINUM [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 44.7FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

BENTONITE SEAL
LENGTH: 34.5
[ ] CHIPS [ ] PELLETS [ ] GRANULAR
[ ] SLURRY
[ ] SATURATED ZONE [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 9.8FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 42.2FT.

SCREEN MATERIAL
[ ] STEEL [X] THERMOPLASTIC (PVC)
[ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	6.3	SLT
6.3	7.4	STY GRVL
7.4	11.2	CLY SLT
11.2	21.9	SDY SLT
21.9	23.6	STY CLY
23.6	40.0	SND SLT
40.0	52.0	SND
TOTAL DEPTH:		52.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/24/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____ / APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO	DATE RECEIVED
00304706	03/14/2016
CR NO	CHECK NO.
	170083
STATE WELL NO	REVENUE NO.
A206427 03/15/2016	031416
ENTERED NRBASSM	APPROVED BY / ROUTE
PH1 PH2 PH3	
03/14/2016 03/14/2016	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME	CONTACT NAME			VARIANCE GRANTED BY DNR
AMEREN MISSOURI C/O BILL KUTOSKY	AMEREN MISSOURI C/O BILL KUTOSKY			
OWNER ADDRESS	CITY	STATE	ZIP	NUMBER
3750 S LINDEBERGH BLVD	ST LOUIS	MO	63127	
SITE NAME		WELL NUMBER		COUNTY
MERAMEC ENERGY CENTER		MW8		ST LOUIS CITY
SITE ADDRESS		CITY		STATIC WATER LEVEL
8200 FINE ROAD		ST LOUIS		38.2 FT

SURFACE COMPLETION

TYPE
- ☐ ABOVE GROUND
- ☐ FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH ____ FT.
- DIAMETER ____ IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER ____ IN.
- LENGTH ____ FT.

SURFACE COMPLETION GROUT
- ☐ CONCRETE
- ☐ OTHER

LOCATION OF WELL

LAT. 38 ° 24' 7.75"
LONG. 90 ° 20' 14.71"

SMALLEST ____ 1/4 ____ 1/4 ____ 1/4 LARGEST

SEC. LG000050 TWN. ____ NORTH
RANGE ____ Direction E

MONITORING FOR:
- ☐ RADIONUCLIDES
- ☐ EXPLOSIVES
- ☐ SVOCS
- ☐ PETROLEUM PRODUCTS ONLY
- ☐ METALS
- ☐ VOC
- ☐ PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- ☐ GAS MIGRATION WELL
- ☐ EXTRACTION WELL
- ☐ PIEZOMETERS
- ☐ DIRECT PUSH
- ☐ X OBSERVATION
- ☐ OPEN HOLE

☐ LOCKING CAP
☐ WEEP HOLE

ELEVATION ____ FT.

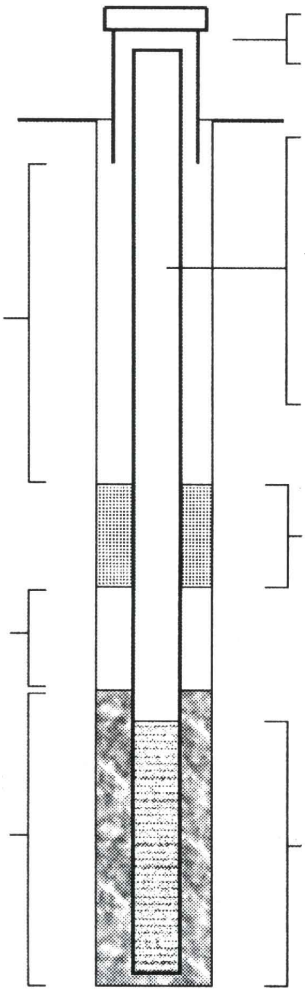
ANNULAR SEAL
LENGTH ____ FT.
- ☐ SLURRY
- ☐ PELLETS
- ☐ CEMENT/SLURRY
- ☐ CHIPS
- ☐ GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY FILTER PACK: 80.0FT.

LENGTH OF PRIMARY FILTER PACK: 0.0FT.



SURFACE COMPLETTION
- ☐ STEEL
- ☐ ALUMINUM
- ☐ PLASTIC

RISER
RISER PIPE DIAMETER 0.0IN.
RISER PIPE LENGTH 0.0FT.
HOLE DIAMETER 0.0IN.
WEIGHT OR SDR# 0.0

MATERIAL
- ☐ STEEL
- ☐ THERMOPLASTIC (PVC)
- ☐ OTHER

BENTONITE SEAL
LENGTH:
- ☐ CHIPS
- ☐ PELLETS
- ☐ GRANULAR
- ☐ SLURRY
- ☐ SATURATED ZONE
- ☐ HYDRATED

SCREEN
SCREEN DIAMETER: 0.0IN.
SCREEN LENGTH: 0.0FT.
DIAMETER OF DRILL HOLE: 0.0IN.
DEPTH TO TOP 80.0FT.

SCREEN MATERIAL
- ☐ STEEL
- ☐ THERMOPLASTIC (PVC)
- ☐ OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	0.9	GRVL
0.9	1.2	SND
1.2	7.1	SDY SLT
7.1	10.0	CLY SLT
10.0	20.0	STY CLY
20.0	21.7	CLY SND
21.7	30.0	STY CLY
30.0	32.8	SDY SLT
32.8	50.0	STY CLY
50.0	68.0	SDY SLT
68.0	75.5	STY SND
75.5	75.9	SND
75.9	80.0	STY CLY
TOTAL DEPTH:		80.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR)	PERMIT NUMBER	DATE WELL DRILLING WAS COMPLETED
x JOHN SUOZZI	006284	01/24/2016

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

☐ PUMP INSTALLED

SIGNATURE (WELL DRILLER)	PERMIT NUMBER	SIGNATURE (APPRENTICE)	APPRENTICE PERMIT NUMBER
x JASON DRABEK	004484	x	

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00305960	DATE RECEIVED 05/26/2016
CR NO	CHECK NO. 170099
STATE WELL NO A206734 05/31/2016	REVENUE NO. 052616
ENTERED NRBASSM PH1 PH2 PH3 05/26/2016 05/26/2016 05/26/2016	APPROVED BY
	ROUTE

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY			VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 370 S LINDBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127	
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER BMW1		COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE RD		CITY ST LOUIS		STATIC WATER LEVEL 25.42 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

LOCATION OF WELL

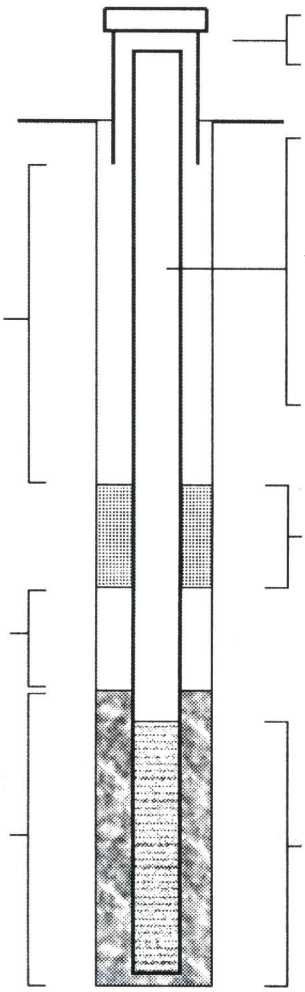
LAT. 38 ° 24' 6.91"
LONG. 90 ° 19' 59.74"

SMALLEST _____ 1/4 LARGEST _____ 1/4 _____ 1/4

SEC. LG000050 TWN. _____ NORTH
RANGE _____ Direction

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [ ] PETROLEUM PRODUCTS ONLY
- [ ] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE



- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION _____FT.

ANNULAR SEAL
LENGTH 37.5FT.
- [ ] SLURRY
- [ ] PELLETS
- [ ] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.0FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 55.9FT.

LENGTH OF PRIMARY FILTER PACK: 14.1FT.

SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
RISER PIPE DIAMETER 2.0IN.
RISER PIPE LENGTH 52.7FT.
HOLE DIAMETER 6.0IN.
WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 5.0
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
SCREEN DIAMETER: 2.0IN.
SCREEN LENGTH: 9.8FT.
DIAMETER OF DRILL HOLE: 6.0IN.
DEPTH TO TOP 60.2FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	1.1	CON
1.1	27.8	STY CLY
27.8	28.6	STY CLY
28.6	37.1	STY CLY
37.1	40.0	CLY SLT
40.0	48.1	CLY SND
48.1	50.0	SND
50.0	51.1	STY CLY
51.1	51.3	CLY SND
51.3	53.8	CLY SND
53.8	60.0	SND
60.0	64.0	STY CLY
64.0	66.2	CLY SLT
66.2	70.0	STY CLY
TOTAL DEPTH:		70.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JEFFREY INGRAM	PERMIT NUMBER 006124	DATE WELL DRILLING WAS COMPLETED 04/08/2016
I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS		[ ] PUMP INSTALLED
SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____	APPRENTICE PERMIT NUMBER _____

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
(573) 368-2165

MONITORING WELL CERTIFICATION RECORD

REF NO 00304708	DATE RECEIVED 03/14/2016
CR NO	CHECK NO. 170083
STATE WELL NO A206429 03/15/2016	REVENUE NO. 031416
ENTERED NRBASSM PH1 PH2 PH3 03/14/2016 03/15/2016 03/15/2016	APPROVED BY
ROUTE	

INFORMATION SUPPLIED BY PRIMARY CONTRACTOR OR DRILLING CONTRACTOR

NOTE: THIS FORM IS NOT TO BE USED FOR NESTED WELLS

OWNER NAME AMEREN MISSOURI C/O BILL KUTOSKY	CONTACT NAME AMEREN MISSOURI C/O BILL KUTOSKY			VARIANCE GRANTED BY DNR NUMBER
OWNER ADDRESS 3750 S LINDEBERGH BLVD	CITY ST LOUIS	STATE MO	ZIP 63127	
SITE NAME MERAMEC ENERGY CENTER		WELL NUMBER BMW2		COUNTY ST LOUIS CITY
SITE ADDRESS 8200 FINE ROAD		CITY ST LOUIS		STATIC WATER LEVEL 14.11 FT

SURFACE COMPLETION

TYPE
- [X] ABOVE GROUND
- [ ] FLUSH MOUNT

LENGTH AND DIAMETER OF SURFACE COMPLETION
- LENGTH 5.0 FT.
- DIAMETER 4.0 IN.

DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED
- DIAMETER 12.0 IN.
- LENGTH 2.5 FT.

SURFACE COMPLETION GROUT
- [X] CONCRETE
- [ ] OTHER

LOCATION OF WELL

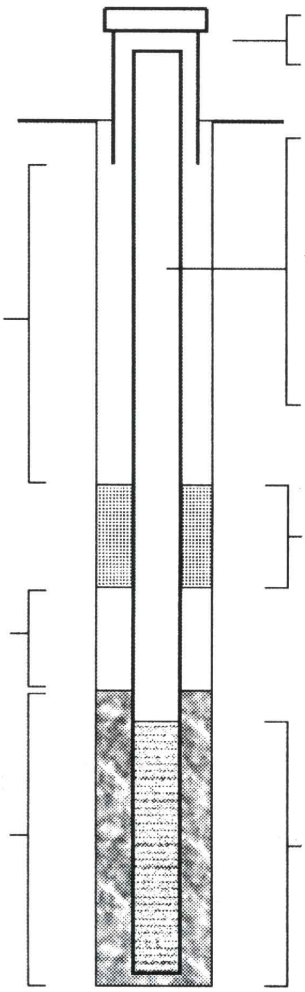
LAT. 38 ° 24' 33.7"
LONG. 90 ° 20' 20.37"

SMALLEST _____ 1/4 _____ 1/4 _____ 1/4 LARGEST

SEC. LG000050 TWN. _____ NORTH
RANGE _____ Direction E

MONITORING FOR:
- [ ] RADIONUCLIDES
- [ ] EXPLOSIVES
- [ ] SVOCS
- [X] PETROLEUM PRODUCTS ONLY
- [X] METALS
- [ ] VOC
- [ ] PESTICIDES/HERBICIDESS

PROPOSED USE OF WELL
- [ ] GAS MIGRATION WELL
- [ ] EXTRACTION WELL
- [ ] PIEZOMETERS
- [ ] DIRECT PUSH
- [X] OBSERVATION
- [ ] OPEN HOLE



- [ ] LOCKING CAP
- [ ] WEEP HOLE

ELEVATION _____FT.

ANNULAR SEAL
LENGTH 0.0FT.
- [ ] SLURRY
- [ ] PELLETS
- [ ] CEMENT/SLURRY
- [ ] CHIPS
- [ ] GRANULAR

IF CEMENT/BENTONITE MIX:
BAGS OF CEMENT USED:
%OF BENTONITE USED:
WATER USED/BAG: GAL.

SECONDARY FILTER PACK
LENGTH: 0.7FT.

DEPTH TO TOP OF PRIMARY
FILTER PACK: 42.0FT.

LENGTH OF PRIMARY FILTER PACK: 8.0FT.

SURFACE COMPLETTION
- [ ] STEEL
- [X] ALUMINUM
- [ ] PLASTIC

RISER
- RISER PIPE DIAMETER 2.0IN.
- RISER PIPE LENGTH 39.7FT.
- HOLE DIAMETER 6.0IN.
- WEIGHT OR SDR# SCH40

MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

BENTONITE SEAL
LENGTH: 31.5
- [ ] CHIPS
- [ ] PELLETS
- [ ] GRANULAR
- [ ] SLURRY
- [ ] SATURATED ZONE
- [ ] HYDRATED

SCREEN
- SCREEN DIAMETER: 2.0IN.
- SCREEN LENGTH: 4.8FT.
- DIAMETER OF DRILL HOLE: 6.0IN.
- DEPTH TO TOP 45.2FT.

SCREEN MATERIAL
- [ ] STEEL
- [X] THERMOPLASTIC (PVC)
- [ ] OTHER

DEPTH FROM	DEPTH TO	FORMATION DESCRIPTION
0.0	6.9	CLY SLT
6.9	35.6	STY CLY
35.6	38.8	CLY SLT
38.8	41.4	STY GRVL
41.4	50.0	STY CLY

TOTAL DEPTH: 50.0 FEET

FOR CASED WELLS, SUBMIT ADDITIONAL AS BUILT DIAGRAMS SHOWING WELL CONSTRUCTION DETAILS INCLUDING TYPE AND SIZE OF ALL CASING, HOLE DIAMETER AND GROUT USED.

SIGNATURE (PRIMARY COUNTRACTOR) x JOHN SUOZZI	PERMIT NUMBER 006284	DATE WELL DRILLING WAS COMPLETED 01/25/2016

I HEREBY CERTIFY THAT THE MONITORING WELL HEREIN DESCRIBED WAS CONSTRUCTED IN ACCORDANCE WITH MISSOURI DEPARTMENT OF NATURAL RESOURCES REQUIREMENTS FOR THE CONSTRUCTION OF MONITORING WELLS

- [ ] PUMP INSTALLED

SIGNATURE (WELL DRILLER) x JASON DRABEK	PERMIT NUMBER 004484	SIGNATURE (APPRENTICE) x _____	APPRENTICE PERMIT NUMBER _____

APPENDIX J
STATISTICAL ANALYSIS PLAN

Statistical Analysis Plan

STATISTICAL ANALYSIS PLAN

Prepared in accordance with the United States Environmental Protection Agencies Coal Combustion Rule, part 40 CFR 257.93 for Ameren Missouri's Surface Impoundment at the Meramec Energy Center, St. Louis County, Missouri

Submitted To: Ameren Missouri
1901 Chouteau Avenue
St. Louis, Missouri 63103

Submitted By: Golder Associates Inc.
820 S. Main Street, Suite 100
St. Charles, MO 63301 USA

Date: October 16, 2017

Project No.153-1406

EXECUTIVE SUMMARY

This 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). The Rule requires owners or operators of an existing Coal Combustion Residuals (CCR) Surface Impoundment to install a groundwater monitoring system and develop a sampling and analysis program (§§ 257.90 - 257.94). Ameren Missouri has determined that the Surface Impoundments at the Meramec Energy Center in St. Louis County, Missouri is subject to the requirements of the CCR Rule.

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 to establish background conditions, to implement detection monitoring, and to implement assessment monitoring (if needed) for Ameren Missouri at the above mentioned CCR Unit. Detailed information on collection, sampling techniques, preservation, etc. are provided in the Groundwater Monitoring Plan (GMP) for the CCR Unit specified above. This SAP is a companion documents 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 GMP.

This SAP was prepared by Golder Associates, Inc. (Golder) on behalf of Ameren in order to document appropriate method 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 Section §257.93(g) of the CCR Rule.

Table of Contents

List of Tables

1.0 BASELINE STATISTICS

This section discusses the procedures, methods, and processes that will be implemented as part of the Detection Monitoring statistical evaluation. Detection Monitoring will begin after eight rounds of sampling are completed at each monitoring well for each of the Appendix III and Appendix IV parameters. This background monitoring period provides baseline data for each monitoring well which can be used as the basis of the statistical evaluation. Detection monitoring will be completed on a semiannual basis unless adequate groundwater flow is not available for semiannual sampling and proper documentation as outlined in §257.94(d) is completed. Detection monitoring will analyze for Appendix III analytes as outlined in the Groundwater Monitoring Plan for this CCR Unit.

1.1 STATISTICAL DATA PREPARATION AND INITIAL REVIEW

Many of the statistical comparison tests used in detection, and assessment 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 this initial review of the data. The analyses required include testing for statistical independence, physical independence, and procedures to evaluate potential outliers.

1.1.1 Physical and Statistical Independence of Groundwater Samples

Detection, and Assessment 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 in order 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.

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
MW-1	85.14	0.0023	0.35	0.5	0.9
MW-2	92.34	0.0023	0.35	0.5	0.8
MW-3	184.68	0.0023	0.35	0.5	0.4
MW-4	46.17	0.0023	0.35	0.5	1.6
MW-5	56.15	0.0023	0.35	0.5	1.4
MW-6	37.44	0.0023	0.35	0.5	2.0
MW-7	49.40	0.0023	0.35	0.5	1.5
MW-8	5.35	0.0023	0.35	0.5	14.2
MW-B1	2.81	0.0023	0.35	0.5	27.1
MW-B2	106.19	0.0023	0.35	0.5	0.7

Notes:
1. Average hydraulic gradient and effective porosity taken from table 2 in the Groundwater Monitoring Plan (GMP)
2. Hydraulic Conductivity taken from table 3 of the Groundwater Monitoring Plan (GMP)
3. Calculation completed using the Darcy Equation as outlined in section 14.3.2 of the Unified Guidance.

1.1.2 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 the data being used to calculate statistical limits.

1.1.2.1 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 1.1.2.2 below.

1.1.2.2 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 produces a more conservative statistical limit, since the data variability is decreased, thereby decreasing the standard deviation.

1.2 Upgradient Monitoring Wells

Following the identification and removal of outliers, the upgradient data are further reviewed to determine appropriate methods for statistical evaluation to maintain adequate statistical power while minimizing the chance of false positives. The following sections describe the procedures and methods that should be used, based on the background dataset, to compare the background datasets, to calculate the data distribution, to handle non-detect (ND) data, and to select appropriate statistical evaluation methods (interwell vs intrawell).

1.2.1 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.

1.2.1.1 Reporting of Low and Zero Values

1.2.1.1.1 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 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 non-detects.

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. This is discussed in more detail in Section 1.3.5 of this document.

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

1.2.2 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:

[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).

- 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.

1.2.3 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. A statistically significant increasing or decreasing trend could indicate a release from the CCR unit (or alternative source) and further investigation of the cause of the trend may be necessary.

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). If a statistically significant trend is reported, based on a Sen's slope/Mann-Kendall trend test, the source of the trend should be investigated. If the trend can be shown to be a result of an upgradient or off-site source, the data can be de-trended and used to calculated statistical limits. De-trending can be accomplished by computing a linear regression on the data (see Section 17.3.1 of the Unified Guidance) and then using the regression residuals instead of the original measurements in subsequent statistical analysis.

1.2.4 Comparing Background Datasets (Spatial Variation)

After physical independence, outlier, trend, and summary statistical testing is completed, the datasets from the background monitoring wells should be compared to one another for each individual constituent. The comparison of these background datasets is useful for determining whether spatial variability exists in the background dataset, and can also be used to decide whether an interwell or intrawell approach is more appropriate for statistical evaluation.

Box and whisker plots can be used to perform side by side comparison for each well and can be completed for each individual analyte to determine if the variance is equal across the background datasets. If the box plots appear to be staggered and do not appear to be from the same population (same variance) then a Lavene's test using an α of 0.01 should be used as a check to determine if the background datasets have spatial variation. Testing methods and procedures are provided in Section 11.2 of the Unified Guidance.

The preferred method for comparing background datasets is a Mann-Whitney (or Wilcoxon Rank Sum) Test, which evaluates 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 from the same statistical distribution. The testing methods and procedures for this analysis are provided in Section 16.2 of the Unified Guidance.

If spatial variability is identified within the background dataset, an additional investigation may be needed in order to confirm that the variability is not caused by impacts from the CCR unit. If there is spatial variability and it is not caused by impacts from the CCR Unit, then an intrawell approach to statistical evaluation may be appropriate.

1.3 Compliance Monitoring Wells and Statistically Significant Increases

After completing the previously described analyses of the background data, a statistical evaluation of the compliance monitoring data should be completed to determine if there are any Statistically Significant Increases[3] (SSIs) that could trigger assessment monitoring. Section §257.93(F) of the CCR Rule specifies the list of methods that can be used for statistical evaluation. These specific methods to be used for statistical evaluation of data from the RMSGS are detailed below. Further, the Unified Guidance is recommended in the CCR Rule to be used for guidance in the selection of the appropriate statistical evaluation method. This section provides a guide to choosing the correct statistical evaluation to analyze the compliance wells for SSIs, the basic principles of each method, and response activities for identified SSIs.

[3] SSI = a verified statistical exceedance; under compliance monitoring programs, the first time an exceedance is reported it is an initial statistical exceedance and is only considered an SSI if a confirmatory result verifies the initial exceedance.

1.3.1 Interwell vs Intrawell Statistical Analysis

1.3.1.1 Interwell Statistical Analysis

An interwell statistical evaluation compares the groundwater results from the compliance (downgradient) monitoring wells to a pool of background (typically upgradient) monitoring well results. If results from the downgradient wells are statistically higher (or significant) than the background dataset then an exceedance is triggered. This upgradient verses downgradient method typically assumes that:

- Naturally, un-impacted groundwater characteristics in the compliance monitoring wells is comparable and equal on average to the background monitoring wells.
- Upgradient and downgradient monitoring well samples are drawn from the same aquifer and are screened in essentially the same hydrostratigraphic position.
- The aquifer unit is homogeneous and isotropic.
- Groundwater flow is in a definable pathway from upgradient to downgradient wells beneath the CCR Unit.

An interwell approach is preferable for statistical evaluation because it compares data to a background dataset that is not influenced by the CCR Unit. Interwell methods should be used with two exceptions: (1) there are significant differences in the datasets of the background wells (as indicated by methods described in Section 1.2.4) or (2) it can be demonstrated that groundwater geochemistry at all wells (background and compliance) is not impacted by the CCR Unit.

1.3.1.2 Intrawell Statistical Analysis

An intrawell statistical evaluation compares the groundwater results from a compliance monitoring well to historical data collected from that same compliance monitoring well. This method can be used for CCR monitoring when groundwater data from the background monitoring wells is statistically different than that of the compliance monitoring wells or when it can be shown that there is no impact from the CCR Unit in either upgradient or downgradient/compliance wells.

1.3.2 Statistical Power

As discussed above, 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 SSI while also maintaining sufficient statistical power to detect a true SSI. Falsely triggering a SSI when no release from the CCR unit has occurred is referred to as a false positive. 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 SSIs depends on the selection of an appropriate FPR, which is referred to as the statistical power. FPRs are set for each parameter (or for each

parameter in each well for intrawell analysis). 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. When the individual FPRs are integrated over the entire statistical monitoring program, it is referred to as the site-wide false positive rate (SWFPR), which is a better measure of the ability of the entire statistical program to detect false positive observations.

1.3.2.1 Site-Wide False Positive Rate

For CCR monitoring, detection monitoring events are based on multiple comparisons, which include the seven (7) Appendix III parameters, at each compliance monitoring well. The SWFPR can be calculated based on several input parameters, including the assumed FPR, the number of downgradient monitoring wells (n), the number of parameters, and the number of statistical comparisons events in a given year for the CCR Unit. The Unified Guidance recommends that a statistical evaluation program be designed with an annual, cumulative SWFPR of approximately 10%.

The Unified Guidance recommends measuring statistical power using power curves which display the probability that an individual comparison will detect a concentration increase relative to background results. After determining the statistical method based on the background data, a power curve can be generated in order to determine the statistical power of the compliance monitoring program. The methods and procedures for calculating the SWFPR are described in Section 6.2.2 of the Unified Guidance.

1.3.2.2 Verification Sampling

Verification Sampling is an important aspect of the SAP as it improves statistical power while maintaining the SWFPR. Most statistical evaluations incorporate verification sampling mathematically into their determination of the SWFPR. Verification sampling is typically completed at a 1 of 2 pass strategy. As described above if an initial statistical exceedance is reported, then verification sampling will be performed to confirm the initial exceedance. Verification samples should be collected on a schedule that allows for physical independence of the samples. In a 1 of 2 pass strategy, if the concentration of the verification sample is less than the calculated compliance limit, then no SSI is triggered. If the initial and subsequent verification observation are above the calculated compliance limit, a SSI is triggered.

Due to the time constraints for reporting put forth in the CCR rule, it is suggested that verification sampling not be completed at the next regularly scheduled sampling event, but instead be collected prior to the next sampling event. Verification sampling within 90 days (assuming a 1 of 2 pass verification sampling strategy) will typically allow sufficient time to complete laboratory and statistical analysis in accordance with the timeframes set forth in the CCR Rules.

1.3.3 Statistical Evaluation Methods

As outlined above, the CCR rule list 5 possible methods for statistical evaluation. The different methods that can be employed for CCR monitoring as outlined in §257.93(F) are:

- ***§257.93(F)(1)*** *"A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent."*
- ***§257.93(F)(2)*** *"An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent."*
- ***§257.93(F)(3)*** *"A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit."*
- ***§257.93(F)(4)*** *"A control chart approach that gives control limits for each constituent."*
- ***§257.93(F)(5)*** *"Another statistical test method that meets the performance standards of paragraph (g) of this section."*

1.3.4 Prediction Intervals

Section §257.93(F)(3) outlines using prediction intervals or tolerance intervals for statistical evaluation. Based on recommendation from the Unified Guidance, prediction limits are the preferred method for calculating detection monitoring compliance limits and will be used to calculate compliance limits for the seven Appendix III constituents. In addition, the Unified Guidance suggests using prediction limits with verification sampling (Chapter 19 of the Unified Guidance), because prediction limits help to maintain low SWFPR while still providing high statistical power. Tolerance intervals, which are a backward looking procedure, should not be used for detection monitoring, but will likely be used in assessment monitoring, as further described in Section 2.0 below. If, at any point in the future, a different statistical method becomes more applicable to the site conditions, this document may be modified to include that method as recommended by the Unified Guidance.

Prediction interval methods can be used for parametric and non-parametric datasets as well as for intrawell or interwell statistical analysis. Prediction limits use background data from either background monitoring wells for interwell analysis or from historical data for intrawell analysis calculate a concentration that represents an upper limit of expected future concentrations for a particular population. In contrast to tolerance limits, prediction intervals are a forward looking, predictive analysis, which incorporate uncertainty in future measurements, and are thus the most appropriate method for detection monitoring programs. Typically, a one-sided upper prediction limit is used to evaluate detection monitoring observations. Observations must be lower than the prediction limit (or within the upper and lower prediction limits for pH) to be considered "in control". Parametric methods are generally preferred over non-parametric methods, because they result in lower SWFPRs and higher statistical power.

For detection monitoring, if parametric testing is required, the procedures outlined in Section 19.3.1 of the Unified Guidance should be used to calculate prediction limits for the statistical analysis. If non-parametric testing is required, the procedures outlined in Section 19.4.1 of the Unified Guidance should be used to calculate prediction limits. Most groundwater statistical software includes algorithms for calculating either parametric or non-parametric prediction limits.

1.3.5 Double Quantification Rule

In situations where the entire background dataset is reported as ND or Estimated (J-flag), the Double Quantification Rule (DQR) will be used to supplement the prediction limit analyses. Generally, the Appendix III constituents occur at detectable concentrations in natural groundwater; however, if ND results are encountered for a given constituent, the DQR can be implemented. A demonstration that this statistical evaluation is as least as effective as any other test and results as described in §257.93(f)(5) can be made. The DQR is recommended by the Unified Guidance as a supplement to prediction limits because it reduces the number of non-detects used for statistical analysis and provides a lower SWFPR while maintaining statistical power.

Under the DQR, a SSI is triggered if a compliance well observation is higher than the reporting limit (RL)/PQL in either (1) both a detection monitoring sample and its verification resample, or (2) two consecutive sampling events in a program were resampling is not utilized.

1.4 Responding to SSIs

If the statistical evaluation for an Appendix III analyte triggers a SSI, the data must be evaluated to determine if the cause of the SSI is due to a release from the CCR Unit or from an alternative source. Possible alternative sources may include laboratory causes, sampling causes, statistical evaluation causes, or natural variation. If the SSI can be attributed to one of these sources and the SSI was not caused by the CCR Unit, 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. If the SSI cannot be attributed to an alternative source and is from the CCR Unit, then Assessment Monitoring is triggered.

1.5 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, assuming no verification sampling). 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 if the "new" data should be included in the background:

- Time Series Graphs – As described in Section 1.1.2.1, 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 is 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 prediction limits will be recalculated, as described in Section 1.3.4 above.

2.0 ASSESSMENT MONITORING STATISTICAL EVALUATION

This section discusses the procedures, methods, and processes that will be implemented as part of the assessment monitoring statistical evaluation, if required. Assessment monitoring will be initiated if a SSI is triggered during detection monitoring. As per the CCR Rule in Section §257.95(b), assessment monitoring must be initiated within 90 days of identifying an SSI (not the sample event which provided the data that resulted in the SSI). This 90-day period includes sampling the groundwater monitoring network for the Appendix IV constituents. Following the initial sampling event for all Appendix IV constituents, the monitoring network is then sampled again within 90 days of receiving the results from the initial Appendix IV sampling event. Following these initial assessment monitoring events, assessment monitoring is performed on a semiannual basis. During one of the two semiannual events, the full list of Appendix IV constituents must be tested. During the second assessment monitoring event of each year, only the Appendix IV constituents that are detected during the previous semiannual event are required to be monitored. Assessment monitoring is terminated if concentrations for all Appendix III and Appendix IV constituents in all compliance wells are statistically lower than background for two consecutive sampling events (§257.95(e)). The following sections discuss the procedures, methods, and processes that will be implemented as part of the assessment monitoring statistical evaluation. As discussed in Section 1.1 of this document, many of the statistical comparisons used in assessment monitoring require various analyses to be completed prior to the data being accepted into the statistical evaluation. Before using the results from assessment monitoring, the steps outlined in Sections 1.1 and 1.2 will be completed. Please refer to those sections for descriptions on the methods and techniques required to complete these analyses.

2.1 Establishing a Ground Water Protection Standard (GWPS)

Following the removal of outliers and the performance of general statistics described in Sections 1.1 and 1.2, GWPS will be developed for use in the assessment monitoring program. The GWPS is a key element to the assessment monitoring process. GWPS must be generated for each of the detected Appendix IV analytes. If interwell methods are utilized (preferred method), a site-wide GWPS will be generated for each analyte based on Appendix IV results reported for background/hydraulically upgradient wells. If intrawell methods are utilized, a well specific GWPS will be generated for each analyte.

For Appendix IV parameters that have a maximum contaminant level (MCL), as established by the United States Environmental Protection Agency, the GWPS is set equal to the MCL. For those constituents whose background concentration are greater than the MCL, the GWPS will be calculated from the background data. Finally, for those constituents that do not have an established MCL, the GWPS will be calculated. Several analytes (cobalt, lead, lithium, and molybdenum) do not have MCLs established and therefore the GWPS must be calculated based on their background concentrations.

2.1.1 Maximum Contaminant Level (MCL) Based GWPS

Many of the Appendix IV analytes have USEPA MCL levels. As specified in the CCR Rule in Section §257.95(b), the GWPS must either be the MCL, or a limit based on background data, whichever is greater. This section describes the methods to be used for statistical analysis when the MCL is to be used as the GWPS.

For Assessment Monitoring, the Unified Guidance recommends the confidence interval method to evaluate for potential exceedances, which are referred to as "statistically significant levels" (SSLs) (Chapter 21, Unified Guidance). Using confidence intervals, SSLs are 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 utilized.

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 1 below is based on Table 4-4 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 Upper Confidence Limit (UCL) and Lower Confidence Limit (LCL) is provided in the section reference from the Unified Guidance, which is listed in the last column of Table 1, 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)
Residuals After Subtracting Trend are Normal (with equal variance)	Low	Trend	Confidence Band Around Linear Regression (Section 21.3.1)
Residuals after Subtracting Trend are Non-Normal	Low	Trend	Confidence Band Around Theil-Sen Line (Section 21.3.2)

In an assessment monitoring program the LCL is of prime interest. If the LCL exceeds the GWPS, there is statistical evidence that a SSL has been triggered. An initial SSL should be confirmed by verification sampling. If only the UCL exceeds the GWPS while the LCL is below the GWPS, the test is considered inconclusive and the Unified Guidance recommends that this situation be interpreted as ”in compliance”. If both the UCL and the LCL are below the GPWS, the data are also “in compliance” with the GWPS.

It is important to note that a slightly different set of criteria are used to determine whether assessment monitoring can be terminated. Additional discussion of the criteria used for exiting assessment monitoring and returning to detection monitoring is provided below in Section 2.2.

During Assessment Monitoring, 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 assessment 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.

2.1.2 Non-MCL Based GWPS

Background or historical concentration limits should be assessed using the following techniques for all Appendix IV analytes. These concentration limits should then be compared with the MCL, if available, and the higher of these two values will be used as the GWPS.

The Unified Guidance provides two acceptable approaches for establishing a non-MCL based GWPS (unless all values are ND, in which case the Double Quantification Rule as described above in Section 1.3.5 should be used). The two methods include the tolerance interval approach or the prediction interval approach.

2.1.2.1 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 2.1.2.2 below.

The Upper Tolerance Limit (UTL) is calculated for each detected 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 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 ($1-\alpha$)), which is used to set the confidence of the test. Typically, the UTL is calculated to have a coverage and confidence of 95%. When an MCL does not exist or the background concentrations are greater than the MCL, the calculated UTL for each constituent is used as the GWPS. The confidence interval for each compliance well 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 detected Appendix IV constituents in each compliance monitoring well (or four “new” assessment

monitoring observations in each well when intrawell statistical methods are employed). Using the Tolerance Interval Approach, a statistically significant level (SSL) is triggered when calculated lower confidence limit (LCL) for each compliance well is greater than the GWPS.

Tolerance limits 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.

2.1.2.2 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, ect.), then a Prediction Interval method should be used. This method is very similar to Section 1.3.4 of this document, however, for assessment monitoring, the Unified Guidance suggests using a prediction interval about a future mean for normally/transfomred-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 2.1.2.1, above. As also described above, if the LCL is greater than the calculated prediction limit then an SSL is triggered.

2.2 Returning to Background Detection Monitoring

As specified in 257.95(e) of the CCR Rule, in order to return to detection monitoring, the concentration of all constituents listed in Appendix III and Appendix IV must be shown to be at or below calculated "background (or historical) values" for two consecutive semiannual sampling events. This determination of background values is based on the statistical evaluation procedure established for detection monitoring. Therefore, if prediction limits (with the double quantification rule for analytes with all non-detects) are used for detection monitoring, prediction limits should be calculated and used for all Appendix III and IV analytes to determine when the monitoring program can return to Detection Monitoring. It is important to remember that Appendix IV constituents are only required to be sampled annually with only those Appendix IV constituents that are detected during the previous semiannual event being required to be analyzed during the second semiannual event of a given year. If statistical results demonstrate that concentrations for all constituents are below background levels for a particular event, all Appendix IV constituents should be sampled during the next event in order to achieve this goal of returning to Detection Monitoring. If this

statistical evaluation demonstrates that any of the Appendix III or Appendix IV are at a concentration above background levels, but no SSLs have been triggered, then the CCR unit will remain in assessment monitoring (257.95(f)).

2.3 Response to a SSL

If the assessment monitoring statistical evaluation demonstrates that a SSL has been triggered, then the owner/operator of the CCR unit must complete the following four actions as described in 257.95(g):

1. Prepare a notification identifying the constituents in Appendix IV that have exceeded a CCR Unit specific GWPS. This notification must be placed in the facilities operating record within 30 days of identifying the SSL
2. Define the nature and extent of the release and any relevant site conditions that may affect the corrective action remedy that is ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up releases from the CCR Unit and must include at least the following;
    A. Installation of additional monitoring wells that are necessary to define the contaminant plume,
    B. Collect data on the nature and estimated quantity of the material released,
    C. Install and sample at least one additional monitoring well at the facility boundary in the direction of the contaminant plume migration,
3. Notify off-site property owners if the contamination plume has migrated offsite on to their property, and
4. If possible, provide an alternative source demonstration that determines that the SSL is not caused by a release at the facility within 90 days of completing the statistical evaluation. If no alternative source demonstration can be made and the plume is determined to have come from the CCR Unit then initiate corrective action.

Actions 1-3 must be completed regardless of whether or not an alternate source demonstration can be made.

2.4 Updating Background Values

The background for Assessment Monitoring Parameters should be updated using the same methods and techniques described in Section 1.5 for updating detection monitoring background data.

3.0 REFERENCES

EPRI. 2015. Groundwater Monitoring Guidance for the Coal Combustion Residual Rule. Electric Power Research Institute. November.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Office of Resource Conservation and Recovery – Program Implementation and Information Division. March

USEPA. 2015. Federal Register. Volume 80. No. 74. Friday April 17, 2015. Part II. Environmental Protection Agency. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule/ [EPA-HQ-RCRA-2009-0640; FRL-9919-44-OSWER]. RIN-2050-AE81. April.

APPENDIX K
EXAMPLE FIELD FORMS

Golder Associates 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 (°__)	pH	Spec.Cond. (__S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Redox Potential (+/- mV)	WL (ft TOC)	Appearance of Water and Comments

GROUNDWATER SAMPLE COLLECTION FORM

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:

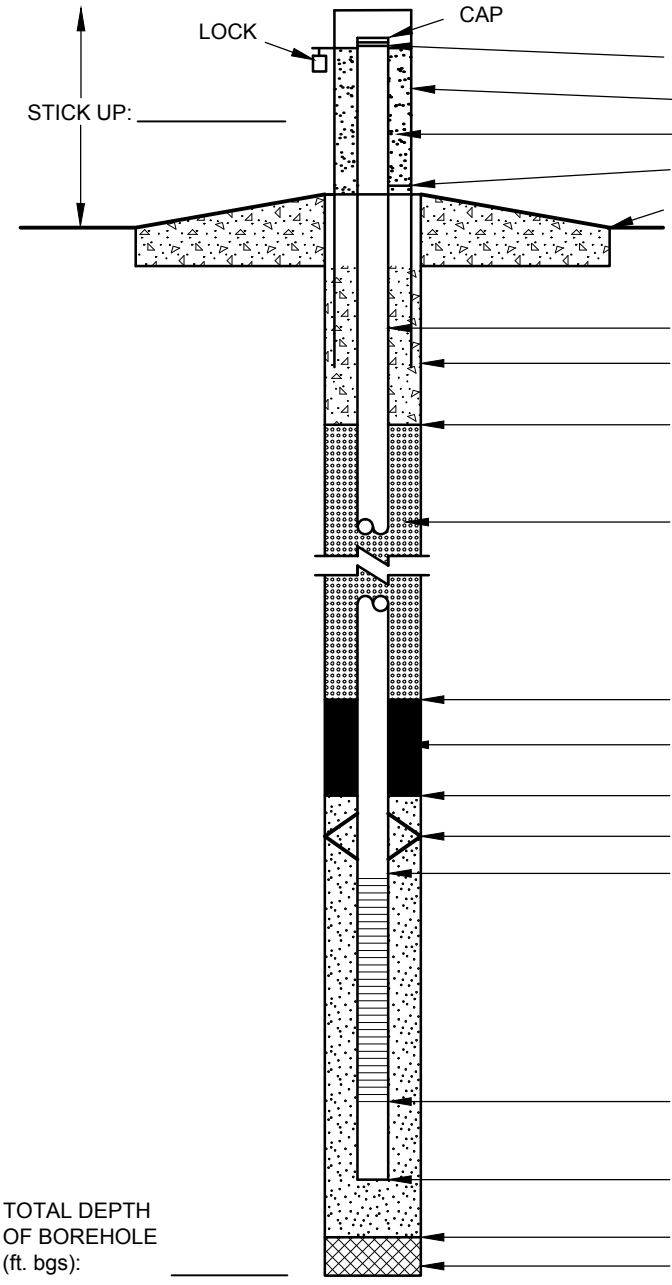
Bailer: PVC/PE Peristaltic Pump Air-Lift Pump

Stainless Steel Submersible Pump Other_____

Teflon Hand Pump

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): _____

TOTAL DEPTH OF BOREHOLE (ft. bgs): _____

BOTTOM OF FILTER PACK (ft. bgs): _____

TYPE AND AMOUNT OF BACKFILL: _____

ADDITIONAL NOTES: _____

CHECKED BY: _____

DATE CHECKED: _____

PREPARED BY: _____

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 ___

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:

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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

Dec 2012

Golder Associates

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity