ASSESSMENT OF CORRECTIVE MEASURES REPORT

CHOCTAW GENERATION LIMITED PARTNERSHIP, L.L.L.P.
2391 PENSACOLA ROAD
ACKERMAN, MS 39735
(662) 387-5758

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ECS
ENVIRONMENTAL COMPLIANCE & SAFETY, INC.

Post Office Box 356
Sherman, Mississippi 38869
Office: (662) 840-5945
Fax: (662) 840-5965
www.envirocomp.net

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FIGURES:

ACRONYMS

ACM	Assessment of Corrective Measures
AMU	Ash Management Unit
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below Ground Surface
BLM	Bureau of Land Management
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
COC	Constituent of Concern
EC	Engineering Control
ECS	Environmental Compliance & Safety, Inc.
EPA	Environmental Protection Agency
gpm	Gallons Per Minute
GWPS	Groundwater Protection Standard
HDPE	High-Density Polyethylene
IC	Institutional Control
MCL	Maximum Contaminant Level
MDEQ	Mississippi Department of Environmental Quality
MNA	Monitored Natural Attenuation
msl	Mean Sea Level
RPB	Reactive Permeable Barrier
RCRA	Resource Conservation and Recovery Act
SSI	Statistically Significant Increase
SSL	Statistically Significant Level

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of the Assessment of Corrective Measures (ACM) Report is to identify and analyze the effectiveness of potential corrective measures, taking into account site-specific conditions, in order to select a remedy(ies) that meets the requirements and objectives specified by the U.S. Environmental Protection Agency (EPA) in 40 Code of Federal Regulations (CFR) Part 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments. As stated in §257.96(a), the ACM is initiated to (1) prevent further releases, (2) remediate any releases, and (3) restore affected areas to original conditions. Specifically, the ACM is required when one or more of the constituents found in Appendix IV to Part 257 is detected at a statistically significant level (SSL) above a groundwater protection standard (GWPS). Within 90 days of making a determination that an Appendix IV constituent has exceeded the GWPS, the owner or operator must either initiate an assessment of corrective measures, as required by §257.96, or must make an alternate demonstration. An alternate demonstration may include determining that a source other than the CCR unit caused the contamination or that the GWPS was exceeded due to an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

Choctaw Generation Limited Partnership, L.L.L.P. (Choctaw Generation) operates one CCR unit – a landfill referred to as the Ash Management Unit (AMU). Because cobalt and lithium have been detected at SSLs exceeding their respective GWPS, Choctaw Generation must prepare an ACM Report to address remediation of the impacted groundwater. The specific requirements of this report are discussed in Section 1.2.

1.2 CCR RULE REQUIREMENTS

Since the Mississippi Department of Environmental Quality (MDEQ) does not have an equivalent, approved program for addressing the federal requirements for disposal of CCR, the requirements of 40 CFR Part 257, Subpart D apply to the CCR unit at Choctaw Generation. Per §257.96(c), the ACM must address the following elements:

1. *The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;*
2. *The time required to begin and complete the remedy; and*
3. *The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(ies).*

These requirements form the basis for the evaluation of potential corrective measures and the selection of a final remedy. These elements shall meet all of the requirements and objectives of the remedy, as described in §257.97 and summarized below:

- Be protective of human health and the environment;
- Attain the groundwater protection standard(s);
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards for management of wastes as specified in §257.98(d).

When evaluating the potential remedies, the owner or operator must consider various aspects of the remedy including the following:

- The long- and short-term effectiveness and protectiveness of the remedy,
- The effectiveness of the remedy in controlling the source to reduce further releases,
- The ease or difficulty of implementing a potential remedy, and
- The degree to which community concerns are addressed by a potential remedy.

This ACM Report has been made part of the Choctaw Generation Operating Record. The results of the ACM will be discussed at least 30 days prior to the selection of a remedy in a public meeting with interested and affected parties per the requirements of §257.96(e).

2.0 BACKGROUND

2.1 SITE DESCRIPTION AND HISTORY

Choctaw Generation is located near the City of Ackerman in Choctaw County, Mississippi in north central Mississippi on a 170-acre site. Choctaw Generation is bounded on the south by Pensacola Road, and is about ½ mile west of US Highway 9. Figure 1 shows the location of the site, as well as the location of the designated CCR monitoring wells. Choctaw Generation operates a single unit electrical generation facility designed to generate electricity for dispatch to the Tennessee Valley Authority (TVA) electrical system. The primary boiler fuel is lignite coal mined by Mississippi Lignite Mining Company ("the Mine") on adjacent property to the north of the power plant. As a result of combusting lignite coal, ash is generated and must be disposed or re-purposed (e.g., Beneficial Use Determination). Choctaw Generation owns and operates an existing Ash Management Unit (AMU) for the placement and disposal of ash. The AMU (or CCR unit) is located in the northeastern portion of the property and consists of three (3) cells, as shown on Figure 1. The AMU encompasses approximately 90 acres of the site.

The AMU is currently regulated by the MDEQ Nonhazardous Solid Waste Management Regulations, found in Title 11, Part 4 of the Mississippi Administrative Code, as a non-municipal (or industrial) solid waste management facility. An initial Solid Waste Management Facility Permit No. SW0100040462 was issued in 1998 and specifies certain landfill construction, operation, and maintenance requirements. The landfill was constructed in phases, or cells, with varying liner systems which include an 18-inch clay liner overlain by a 12-inch drainage layer to collect leachate. The leachate is gravity drained to a leachate pump station and pumped to the AMU Basin, both of which include a clay and 30-mil PVC geomembrane liner. The MDEQ Solid Waste Permit also requires upgradient and downgradient groundwater monitoring in the uppermost aquifer for specific constituents, which began in 2000. Currently three (3) upgradient and three (3) downgradient wells are monitored on a semiannual basis as required by the permit and the approved Groundwater Monitoring Plan.

A lined AMU Basin lies to the northwest of the AMU landfill. The AMU Basin is designed as a no-discharge system and collects both leachate and storm water runoff that has contacted the landfill surface. The water in the AMU Basin is recycled back to the power plant for reuse as ash conditioning water and cooling tower makeup water.

2.2 GEOLOGY

The geology and hydrogeology in the vicinity of the ash management area were initially assessed during two phases of geotechnical investigation performed during the spring and summer of 1997. The AMU is underlain by a complex mixture of clays, silts, silty sands and lignite of the Tuscahoma Formation. The clays are typically thicker and more continuous than the silts and lignites, are gray in color, and are stiff to blocky in texture. The lignite seams are very correlative and are labeled alphabetically. The major seams underlying the site are the F through J seams, which are at approximately 400 to 550 feet mean sea level (msl). Some minor sands do exist, but these typically contain a considerable portion of fines. Due to the complexity presented by correlating the largely discontinuous interbedded clays, silts, and silty sand units, the geologic interpretation of the AMU was simplified using a combination of lithologic logs (constructed from samples in the field), geophysical logs, and geotechnical data. Correlatable lithologies derived from use of these tools include three basic units: (1) generally fine grained material, having interbedded clayey, fine sands with silts of low permeability (1.0 E-7 cm/sec to 9.0 E-9 cm/sec); (2) generally clayey silts, interbedded with silty fine sands with clay; and (3) lignite.

2.3 HYDROGEOLOGY

The hydrogeologic conditions for the AMU are based upon data collected during the installation of the 13 piezometers and monthly water level data collected from June 1997 through November 1997. The piezometers monitored localized permeable zones between the lignite seams. Reviews of hydrographs generated from the water level measurements indicate that the eight (8) piezometers monitored permeable zones between the G and H lignite seams which are not hydraulically connected. This permeable zone generally exists between 400 to 460 feet msl. The shallowest or upper groundwater zone is a perched water table zone that has been eroded away on the north part of the AMU and is not continuous. This is evidenced by the four seeps or springs that were identified in the AMU. This potentiometric surface was initially mapped using November 1997 water level data from piezometers screened in a silty zone between the G and H lignite seams. Groundwater flow direction is to the northwest which correlates with the regional groundwater flow direction. However, these surficial deposits do not contain groundwater that would be used as a drinking water source. The shallowest stratigraphic units containing groundwater used as a drinking water source is the Hatchetigbee Formation, about 100 feet below ground surface (bgs) and up to 170 feet thick, followed by the Tuscahoma Formation, about 300 feet bgs and up to 110 feet thick, both in the Wilcox Group.

Choctaw Generation has three (3) active groundwater wells used to supply make-up water for the cooling towers. These wells are located to the south and southeast of the AMU. All three (3) wells are deepwater wells over 3,000 feet in depth, withdrawing water from the Massive Sand (MSSV) formation in the Tuscaloosa aquifer system.

2.4 CLIMATE

The area around Ackerman, Mississippi is classified as warm and temperate, a humid subtropical climate characterized by hot and humid summers and cool to mild winters, common throughout the southeast U.S. Annual temperatures range between an average low of 35°F in January to an average high of 90°F in July. Annual average precipitation is approximately 56 inches, with the dryer months being August through

October. Prevailing winds occur from the south with an average wind speed of 4.6 miles per hour.

2.5 POPULATION AND LAND USE

The population of nearby Ackerman, Mississippi is approximately 1,535 persons within an area of 2.2 square miles. Choctaw Generation lies about 4 miles north-northwest of Ackerman, in Choctaw County. With exception of the Mine area to the north and the TVA combined cycle natural gas power plant to the southeast, the land cover in the vicinity of the facility is largely deciduous forest with some predominant evergreen and pasture areas. The surrounding area is rural and sparsely populated, with approximately 26 people living within a one-mile radius of the facility. Residences are located either off of Highway 9 to the east and northeast or to the south of Pensacola Road.

Mississippi Lignite Mining Company owns the property to the north and west stretching to the Natchez Trace Parkway about 3.5 to 4 miles from Choctaw Generation. Other than active surface mining areas, there are administrative and other support buildings on the Mine property, as well as areas to stockpile the mined lignite. The offices and stockpile areas are adjacent and northwest of Choctaw Generation. The TVA combined cycle power plant is located to the southeast, on the south side of Pensacola Road. There is also an electrical substation just northeast of Choctaw Generation on Highway 9.

2.6 GROUNDWATER QUALITY

As noted in Section 2.1, Choctaw Generation has had a groundwater monitoring system in place since 2000, monitoring shallow groundwater located generally at depths between 460 and 480 feet msl downgradient of the AMU. The current groundwater monitoring system used to demonstrate compliance with the CCR regulations consists of wells in which groundwater immediately downgradient of the AMU, near the tributary of Little Bywy Creek, is encountered within 3 to 15 feet bgs, with increasing groundwater depths encountered as the surrounding elevation increases. This groundwater is not used as a drinking water source and is likely hydraulically connected to the tributary of Little Bywy Creek, which crosses the northern portion of the property flowing between the north side of the AMU and AMU Basin and CCR-2, CCR-3, and MW-9, then north onto the Mine property. Based on background sampling, the shallow groundwater contains dissolved solids, including calcium, chlorides, fluorides, and sulfates. The groundwater also contains detectable concentrations of naturally occurring minerals, including barium, boron, and manganese.

2.7 OTHER POTENTIAL CONTAMINANT SOURCES

Other potential contaminant sources may exist at the site, though a demonstration of an alternate source impacting groundwater has not been made. Possible alternate or contributing sources include the native soils and the lignite seams which extend throughout the Choctaw Generation site and into the adjacent mine. The Mine also stockpiles lignite directly to the north of the site, which is crushed and loaded onto the belt conveyor feeding the boilers at Choctaw Generation. Lignite and soils contain naturally-occurring metals that are subsequently seen in the ash; therefore, the groundwater and storm water runoff come into direct contact with these materials.

The AMU and AMU Basin could also be a contaminant source and a breach in the bottom liner could potentially allow leachate to reach underlying groundwater. The AMU and AMU Basin are designed as a no discharge system; however, there have been two (2) emergency discharges from the AMU Basin spillway (February and May 2019) due to excessive and abnormal precipitation events. Because the AMU Basin, the spillway (or discharge point) for the AMU Basin, and the lignite storage and conveyor operations are all located to the northwest of the AMU, they are all located within the direction of groundwater flow and could potentially impact downgradient groundwater quality. With this said, Choctaw Generation does not have sufficient data to indicate that any one of these sources has contributed to the GWPS exceedances observed in the shallow groundwater at this time.

3.0 SITE GROUNDWATER MONITORING AND CHARACTERIZATION

40 CFR 257.90 of the CCR Rule requires a groundwater monitoring system be installed and a sampling and analysis program be established for the detection, assessment, and characterization of potential releases from the CCR Unit. Certain constituents listed in Appendix III to the Rule and deemed indicative of a potential release must be monitored during the detection monitoring phase. If monitoring indicates these constituents have increased by a statistically significant amount over the background concentrations established by the groundwater monitoring program, monitoring must be conducted for the constituents listed in Appendix IV of the Rule. Groundwater must then be assessed to determine if any constituents in Appendix IV are detected at statistically significant levels (SSL) above the GWPS established in the CCR Rule. Discussion of these monitoring results and the nature and extent of the release are discussed below.

3.1 SUMMARY OF GROUNDWATER MONITORING

The CCR groundwater monitoring system currently consists of nine (9) downgradient monitoring wells and three (3) upgradient, or background, monitoring wells. The initial groundwater monitoring system was established in 1998 to comply with the MDEQ Solid Waste Management Facility Permit issued the same year and currently consists of upgradient monitoring wells MW-7, MW-13, and MW-14 and downgradient wells MW-9, MW-16, and OW-2. To comply with the CCR Rule, in May 2016 Choctaw Generation installed three (3) additional downgradient monitoring wells (CCR-2, CCR-3, and CCR-4) in the direction of groundwater flow and in close proximity to the electric transmission right-of-way along the north property boundary. The downgradient wells are screened in the uppermost aquifer below the base of the ash fill, which is at approximately 480 feet msl.

Eight (8) rounds of baseline monitoring for Appendix III and Appendix IV constituents were performed from July 2016 through April 2017 to establish the background prediction limits from upgradient wells for comparison to future downgradient results. During the first detection monitoring event conducted in February 2018, Appendix III constituents were detected in downgradient wells with a statistically significant increase (SSI) above the background concentrations. Therefore, Choctaw Generation initiated assessment monitoring. Annual monitoring for all Appendix IV constituents took place during May 2018 and May 2019, though the results of the May 2019 monitoring event are not yet available. As a result of the initial May 2018 event which showed levels of Appendix IV constituents above the GWPS, an additional monitoring well, CCR-5, was installed at the property boundary near the lignite feed to the conveyor in the direction of groundwater flow. Following installation of this well, two (2) semiannual assessment monitoring events for those Appendix IV constituents detected were completed during September 2018 and March 2019. Figure 1 shows the location of the current groundwater monitoring wells for the AMU used to comply with the CCR Rule.

3.2 APPENDIX IV CONSTITUENTS DETECTED ABOVE GWPS

During the initial annual assessment for all Appendix IV constituents conducted in May 2018 in accordance with §257.95(b), cobalt and lithium exceeded the GWPS established per §257.95(h). In the initial annual and subsequent semiannual assessment monitoring events, cobalt has exceeded the GWPS of 0.006 mg/l in monitoring wells MW-9, MW-12, MW-15, MW-16, and CCR-5. Lithium has exceeded the GWPS of 0.050 mg/l in monitoring wells MW-9 and CCR-3. Results from the most recent semiannual assessment monitoring event conducted in March 2019 show an exceedance of the GWPS of 0.004 mg/l for beryllium in monitoring well MW-9, the only well with any detectable concentrations of beryllium thus far. This exceedance has not yet been verified. Results from the March 2019 monitoring event for these three constituents are summarized in Figure 3.

3.3 NATURE OF THE RELEASE

In §257.95(g), the CCR Rule requires the nature and extent of the release from a CCR Unit be characterized, including installation of additional monitoring wells to define the plume, collection of data on the characteristics and amount of material released, and installation of at least one additional well at the facility boundary in the direction of groundwater flow. A potential release from the AMU has been indicated based on results from nearby downgradient monitoring wells, particularly MW-9, which has experienced increasing trends in total dissolved solids, particularly calcium, chlorides, and sulfates, as well as recent detections of beryllium, cobalt, and lithium exceeding the GWPS. Based on data for MW-9 dating back to 2000, there appears to be a distinct increase in many measured groundwater constituents beginning in 2017. Currently, it is unclear if the cobalt detected in the groundwater at other wells is associated with a potential release from the AMU for the following reasons: (1) Cobalt has been detected in many other wells, including CCR-2, CCR-4, MW-12, MW-15, and MW-16, since CCR monitoring began in 2016 but was not detected in MW-9 at the time. (2) These other wells do not exhibit increasing trends, as in MW-9, but generally stable trends. (3) Cobalt is naturally occurring in the lignite mined in this area and also present in the surface water of the stream crossing the property, both at locations upstream and downstream of the AMU.

To help identify the nature of the potential release, samples of fly ash, bed (or bottom) ash, and uncombusted lignite were collected and sampled for Appendix III and Appendix IV constituents. EPA's Toxicity Characteristic Leaching Procedure (TCLP) was used to evaluate the leachability of calcium, cobalt, and lithium. The results, shown in Table 1 below, indicate that the ash has higher concentrations of most constituents, as expected since the organic portion of the lignite would be largely combusted in the boilers leaving behind more concentrated amounts of inorganic constituents, including metals. Also, limestone is added to the boilers to react with sulfur present in the lignite, which results in additional calcium and sulfate expected in the fly ash. The fly ash and bed ash contain cobalt and lithium; however, these do not appear to readily leach from the ash as noted in the TCLP results.

Table 1. Solids Sampling Results

Constituent	Fly Ash (Total)	Bed Ash (Total)	Lignite (Total)	Fly Ash (TCLP)	Bed Ash (TCLP)	Lignite (TCLP)
	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l
Appendix III Constituents						
Calcium	143,000	82,700	14,600	3,070	1,090	217
Chloride	73.5	261	<10	--	--	--
Fluoride	20.5	<1	<1	--	--	--
Sulfate	15,400	2,080	<50	--	--	--
Appendix IV Constituents						
Antimony	<2	<2	<10	--	--	--
Barium	653	89.2	143	--	--	--
Beryllium	4.42	0.624	<1	--	--	--
Cadmium	<0.5	<0.5	<2.5	--	--	--
Chromium	51.4	13.9	5.23	--	--	--
Cobalt	12.3	2.58	<5	<0.1	<0.1	<0.1
Lead	17.6	5.79	2.5	--	--	--
Lithium	41.0	13.7	<25	<0.15	0.192	<0.15

3.4 EXTENT OF THE RELEASE

Per §257.95(g), potential locations for installing additional monitoring wells was evaluated to determine the extent of the potential release. Monitoring wells MW-9, MW-12, and CCR-3 were already installed along the boundary of the electric transmission line right-of-way to the north of the AMU; therefore, the only additional place to install a monitoring well between the AMU and facility boundary in the direction of groundwater flow was near the coal conveyor. Monitoring well CCR-5 was installed in the northwest corner of the property near the coal conveyor storm water pond in early September 2018 and was subsequently sampled in the first semiannual assessment monitoring event conducted in the same month. No additional wells were installed at the time since there was no indication that groundwater contamination had migrated off-site and installation of off-site wells on the adjacent Mine property would require lead time to obtain approval from Mississippi Lignite Mining Company and come to an agreement on the siting of such wells.

The results of semiannual monitoring at CCR-5 have shown an exceedance of the GWPS for cobalt. These exceedances are above any concentrations of cobalt detected in any of the other monitoring wells. Based on the site, indications of a potential release from the AMU would first be expected to be observed in MW-9 (e.g., via elevated total dissolved solids, including calcium, chlorides, and sulfates). However, both MW-12 and CCR-3 have had detectable levels of cobalt since monitoring began in 2016. Because cobalt, as well as other Appendix III constituents, including total dissolved solids, calcium, and sulfate, have been detected in CCR-5 at concentrations well above any other wells, it appears possible that a source other than the AMU could be impacting groundwater quality in the area. The topography in the area is very hilly with CCR-5 located at a low elevation near a tributary of Little Bywy Creek; therefore, it is likely that groundwater to the east and west of CCR-5 may also flow toward the tributary, possibly contributing to the different water chemistry observed in this well.

As a result of the cobalt exceedances in CCR-5, Choctaw Generation approached the Mine to obtain approval and agreement on installation of three (3) additional monitoring wells, CCR-6, CCR-7, and CCR-8, on property owned by the Mine. These wells were recently installed generally northwest, southwest, and northeast of CCR-5 to better ascertain the extent of the potential groundwater contamination and determine if sources other than the AMU are contributing to groundwater quality in this area. These wells were included in the recent annual Appendix IV monitoring conducted in May; however, results have not been obtained and analyzed to determine what, if any, Appendix IV constituents are present in these new wells.

Based on the results currently available, the extent of the groundwater contamination due to a potential release from the AMU extends from the AMU Basin to the north up to and beyond the electric transmission right-of-way. However, further investigation is required to fully delineate the extent of the contamination and provide any estimation of the amount of material released from the AMU or if sources other than the AMU may be responsible.

In addition to groundwater monitoring, surface water samples were collected from the stream flowing east to west along the northern perimeter of the AMU and AMU Basin then turning north and flowing adjacent to the coal conveyor storm water pond. The stream converges with Little Bywy Creek about one mile north of the storm water pond. Three (3) grab samples were collected during a single monitoring event conducted on March 20, 2019, in conjunction with the March 2019 semiannual groundwater assessment monitoring event. The samples were analyzed for the Appendix III constituents and those Appendix IV constituents required for analysis under assessment monitoring. Additionally, a grab sample of storm water runoff collected in the storm water pond near CCR-5 was collected and analyzed for the same constituents. The locations of the sampling and summary of results are show on Figure 4. The results are also provided in Table 2 below and compared to the water quality criteria (WQC) for freshwater bodies classified “Fish and Wildlife” from MDEQ’s Regulations for Water Quality Criteria for Intrastate, Interstate, and Coastal Waters (11 Miss. Admin. Code Part 6, Chapter 2) or EPA’s National Recommended Water Quality Criteria, if MDEQ has no criteria. Both the chronic and acute water quality criteria are provided. The human health value (HHV), as provided by MDEQ or, in absence of an MDEQ value, by EPA, is also provided for the consumption of organisms only.

Table 2. Surface Water Sampling Results

Constituent	Location #1	Location #2	Location #3	SW Pond	WQC[(1), (2)]	HHV[(1), (3)]
Appendix III Constituents						
Boron (mg/l)	<0.050	<0.050	<0.050	<0.050	none	none
Calcium (mg/l)	27.7	61.7	20.8	53.6	none	none
Chloride (mg/L)	2.08	314	319	41.5	230 / 860	none
Fluoride (mg/l)	0.37	0.41	0.57	0.46	none	none
Sulfate (mg/l)	305	244	201	241	none	none
Total Dissolved Solids (mg/l)	306	778	572	561	750 / 1500	none
pH (s.u.)	4.77	5.64	6.61	7.48	6.0-9.0	none
Specific conductance (µS/cm)	375.6	1087	1079	690.7	1000	none
Appendix IV Constituents						
Antimony (mg/l)	<0.005	<0.005	<0.005	<0.005	none	0.64
Barium (mg/l)	0.031	0.062	0.165	0.087	none	none
Beryllium (mg/l)	0.00179	<0.001	<0.001	<0.001	none	none
Cadmium (mg/l	<0.001	<0.001	<0.001	<0.001	0.00015 / 0.00103	0.168
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001	0.042 / 0.323	140
Cobalt (mg/l)	0.0397	0.0361	0.0344	<0.001	none	none
Lead (mg/l)	0.00123	<0.001	<0.001	<0.001	0.00118 / 0.030	none
Lithium (mg/l)	<0.050	<0.050	<0.050	<0.050	none	none

(1) Green values indicate WQC established by MDEQ. Blue values indicate WQC established by EPA.
(2) WQC = Water Quality Criteria for freshwater provided as the chronic criterion followed by the acute criterion.
(3) HHV = Human Health Value for consumption of only organism from freshwater.

Based on observations of this stream, it typically has some minimal flow and appears to be fed by a spring or seep occurring near Highway 9 as visually observed and also noted on a groundwater map prepared for the Mississippi Lignite Mining Company. As noted in the table above, cobalt is detected in surface water at all three locations at fairly consistent concentrations, indicative of possibly naturally-occurring sources contributing to detections of cobalt in the area. Also, Location #1, located upstream of the AMU, has a much lower pH than other monitoring wells in the vicinity of the stream and has a considerable amount of sulfate, indicating the stream may be impacted by another potential contaminant source. The stream could be potentially impacted by the AMU based on the increase of dissolved solids, particularly chlorides, measured from Locations #1 and #2.

3.5 POTENTIAL RISK TO HUMAN HEALTH AND THE ENVIRONMENT

Constituents of concern (COC) found in the groundwater above the GWPS specified in the CCR Rule include Cobalt, Lithium, and recently Beryllium. Human health effects associated with these metals include the following:

- Beryllium: Classified a probable human carcinogen by EPA. Inhalation may cause acute or chronic beryllium disease, which resembles pneumonia. Ingesting beryllium has not been reported to cause effects in humans because so little is absorbed in the stomach and intestines, though adverse impacts have been noted in animals. (Reference: ATSDR (2011). Toxic Substances Portal–Beryllium. *https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=33*. Accessed June 18, 2019.)

- Cobalt: Cobalt is currently not classified by EPA with respect to carcinogenicity. Inhalation may cause lung irritation, including asthma and pneumonia, and has been shown to cause cancer in animals. Ingesting of high doses of cobalt in animals has resulted in birth defects. (Reference: ATSDR (2011). Toxic Substances Portal–Cobalt. *https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=64*. Accessed June 18, 2019.)

- Lithium: The ATSDR has not published a toxicological profile for lithium, and EPA has indicated there is insufficient data to assess its human carcinogenic potential. Long-term use of lithium (such as to treat manic depression) has resulted in adverse renal and neurological side effects. (Reference: U.S. EPA (2008). *Provisional Peer-Reviewed Toxicity Values for Lithium*. EPA/690/R-08/016F. Cincinnati, OH: Superfund Health Risk Technical Support Center.)

In order for COCs to pose a risk to human health or the environment, there must be a complete exposure pathway allowing receptors to come into regular contact with the contaminated media (i.e., groundwater, surface water, air, soil). The three basic exposure pathways include inhalation, ingestion, or direct (dermal) contact. Since the intent of this report is to address a release from the CCR unit, potential exposure to COCs released as a result of normal facility operations are not evaluated in this report (e.g., air emissions from the boiler, leachate/storm water held and reused in the AMU Basin, transfer/handling of ash at the AMU).

Based on site investigations to date, there are currently only two potential exposure routes: (1) Ingestion of impacted groundwater, and (2) Ingestion or direct contact with surface water in the tributary of Little Bywy Creek impacted by contaminated groundwater. A discussion of these pathways is provided below.

Ingestion of Impacted Groundwater

The shallow groundwater currently monitored, in which COCs have been detected at levels exceeding the GWPS, is underlain by clays and silty clays with lignite seams throughout. A suitable aquifer for potential drinking water is not encountered until about 100 feet bgs in the Upper Wilcox Aquifer. Based on the soil types and low vertical hydraulic conductivity measured at the location of the AMU, there is no indication the shallow groundwater could migrate to lower aquifers. Therefore, there is no complete exposure pathway for the ingestion of groundwater impacted by a release at this site. Also, the northwesterly flow of groundwater near the AMU is directed toward the large area owned by the Mine and away from any local residences with private wells, which are located to the south and east/northeast of the site.

Ingestion/Direct Contact of Impacted Surface Water

Hydraulic connections or seeps from the shallow groundwater to surface water in the stream to the north of the AMU are likely given the groundwater elevation in the vicinity of the AMU. At monitoring wells close to the tributary, such as MW-9, MW-12, and CCR-5, groundwater is encountered very near the surface. Also, as noted in Table 2 above, there are indications groundwater is currently impacting surface water quality in the stream.

Both the unnamed tributary and Little Bywy Creek are considered intermittent streams, with flows often dictated by the seasonal variations, groundwater seeps/springs, and local precipitation. Therefore, these streams do not sustain prolonged aquatic life to support fishing and do not serve as recreational (e.g., swimming and boating) or drinking water sources. Little Bywy Creek continues to flow north-northwest, draining into Middle Bywy Creek, a perennial stream. Middle Bywy Creek is not classified as recreational by MDEQ or used as a drinking water source. Since these creeks flow through the Mine property, north toward the Natchez Trace, there are no potential human receptors, other than site workers, since both Choctaw Generation and Mississippi Lignite Mining Company have very stringent site entrance requirements to help enforce site safety regulations.

Any aquatic life in the on-site stream, may be impacted due to the fluctuations in pH from 4.77 to 6.61 noted upstream and downstream and impacts from total dissolved solids. Total dissolved solids, chlorides, and specific conductance are slightly above their respective chronic water quality criteria near and downstream of the AMU. pH is below the State standard upstream but increases to within the pH standards further downstream. Given the intermittent nature of water flow in the stream, the stream is not expected to support aquatic life over any significant period of time; therefore, impacts to the water quality of the stream likely have little impact to any aquatic species downstream or off-site.

3.6 CLEAN UP LEVELS / POINT OF COMPLIANCE

Currently, the CCR Rule requires that remedies be protective of human health and the environment and attain the groundwater protection standards. Currently, the GWPS for cobalt of 6 µg/l and lithium of 40 µg/l specified in §257.95(h)(2) are based on EPA's Regional Screening Levels for tap water for noncancer risk with a target hazard quotient of 1.0. As indicated by their title, these values are generally used as screening levels, with site-specific factors including exposure pathways and mobility of the pollutant considered when determining to what level groundwater should be remediated. Also, the GWPS for beryllium of 4 µg/l is the EPA's maximum contaminant level (MCL) for drinking water. The CCR Rule does not allow for development of site-specific cleanup standards based on potential exposure pathways; therefore, the current GWPS are the levels that must be achieved by the final remedy. Consistent with the federal regulations governing corrective measures at regulated hazardous waste sites, corrective measures will be considered complete if the GWPS are not exceeded for a period of three (3) consecutive years in the monitoring wells located downgradient of the waste boundary.

4.0 ASSESSMENT OF CORRECTIVE MEASURES

The purpose of the ACM Report is to identify, develop, and evaluate potential corrective measure alternatives for the Choctaw Generation site that will prevent further releases, remediate any existing releases, and restore affected areas to their original conditions. Based on current groundwater data indicating a potential release from the AMU, the following sections examine and screen corrective measure alternatives that may be used to remediate the impacts of the release. As noted in Section 3.5, risks to human health and the environment at the site are considered low given that the release is confined to the shallow groundwater which is flowing to the northwest toward the Mine property and away from residential areas.

4.1 OBJECTIVES OF REMEDIAL TECHNOLOGY EVALUATION

Corrective action objectives are intended to protect human health and the environment under both current and future conditions and are based on the objectives outlined in §257.97(b) of the CCR Rule. The corrective action objectives for the selection of a remedy at the Choctaw Generation site include the following:

(1) Protect human health and the environment by minimizing exposure to COCs;
(2) Reduce groundwater contaminants to levels below the GWPS, particularly beryllium, cobalt, and lithium which are currently above their respective GWPS;
(3) Control the release of any additional CCR material to reduce or eliminate further releases of Appendix IV constituents; and
(4) Remove as much of the contaminated material released from the AMU as feasible.

4.2 POTENTIAL SOURCE CONTROL MEASURES

As noted above, control of the release is a priority when evaluating corrective measures for groundwater, because if the release is not controlled, migration of CCR contaminants to the groundwater will continue and remedies employed to restore groundwater to its original condition may never be effective. Potential source control measures include modifying operational practices (e.g., banning waste disposal or reducing water content), repairing liner or other design failures, or excavating waste for treatment and/or off-site disposal. Choctaw Generation is one of the newer coal-fired power plants, having operated for 17 years, and there are no intentions to close the plant and cease generating ash. Therefore, continuing to have an on-site option for waste disposal via the AMU landfill is necessary to economically operate the plant.

Based on recent trends in some downgradient monitoring wells indicating increases in Appendix III and IV constituents or detection of previously undetected constituents, it appears there is a potential for a release from the AMU. In the last few years, the AMU Basin, collecting leachate and storm water runoff from the AMU, has had little freeboard to accommodate precipitation due to lower water usage at the plant from factors such as mechanical outages and low demand, as well as higher precipitation during periods of low evaporation (e.g., during cold months). In order to avoid a discharge from the basin, which is not allowed except during emergency situations, the excess storm water has collected on top of the AMU. The quality of the water in the AMU Basin does not meet the water quality criteria required for a release to surface waters; therefore, it cannot normally be discharged to the nearby stream. The collected storm water on the AMU could potentially cause issues with the AMU liner system resulting in increased mobility of the CCR material or leachate and possible breaches in the liner.

Unfortunately, rainfall from December 2018 through April 2019 has been of historic proportions, resulting in additional ponding on the AMU and in two (2) emergency releases of water from the AMU Basin. Choctaw Generation has had preliminary discussions with MDEQ and is currently in the conceptual design phase with an engineering firm to evaluate temporarily covering a portion of the landfill surface to route clean storm water off the landfill away from the AMU Basin. This has potential to help restore the water balance such that water is no longer allowed to collect on top of the AMU. Removal of the water on the AMU is expected to significantly reduce any potential liner issue and/or risk of a potential release.

Choctaw Generation believes removing excess water from the AMU will make a significant difference over time. These impacts should be observed by a decreasing trend in Appendix III and IV constituents, particularly dissolved solids, particularly in the nearby wells.

4.3 POTENTIAL CORRECTIVE MEASURES

Both active and passive corrective measures may be used to address impacts to the environment, as well as remove or minimize potential exposure pathways. Active measures may include removal of the source and/or contaminated media, in-situ or ex-situ treatment, or containment of the contaminated media; whereas, passive measures rely on natural processes to reduce the toxicity, mobility, or volume of the contaminated media.

As identified in Section 4.2, Choctaw Generation is planning to pursue corrective measures to control the potential source of the release. This will entail removing any storm water accumulated on top of the AMU, preventing emergency AMU Basin discharges, and restoring the site water balance needed. These corrective measures should result in noticeable impacts to groundwater quality. Also, the complete nature and extent of impacts to groundwater have not been fully delineated, and there is insufficient data from newer wells, in particular, to indicate if there are other contributing sources of COCs, cobalt in particular, that would impact remedy selection or allow for an alternate source demonstration.

With the understanding that data gaps exist, and further investigation is needed to delineate the extent and source of groundwater contamination, particularly off-site impacts, final remedy selection will require some additional time to ensure the remedy addresses all the objectives set forth by the CCR Rule. Choctaw Generation will document the progress in selecting and designing the remedy in the semiannual reports required by §257.97(a), followed by a final report describing the selected remedy and detailing how the remedy selected meets the requirements of §257.97.

Based on the current data regarding the nature and extent of contamination at the site, the following corrective measures are further evaluated in Section 4.4 for their potential effectiveness using the criteria set forth in §257.96(c). All of the following alternatives examined include source control as outlined in Section 4.2.

1. Monitored Natural Attenuation
2. In-Situ Chemical Stabilization
3. In-Situ Permeable Reactive Barrier
4. Groundwater Extraction via Pumping
5. Groundwater Extraction via Interceptor Trench

4.4 EVALUATION OF CORRECTIVE MEASURES EFFECTIVENESS

In §257.96(c), the following minimum criteria are required to be evaluated for each corrective measure identified. Each potential corrective measure is further described below, followed by a discussion of these criteria.

1. Performance
2. Reliability
3. Ease of Implementation
4. Safety Impacts
5. Cross-Media Impacts
6. Exposure Control to Residual Contamination
7. Time Required to Begin and Complete the Remedy
8. Institutional Requirements Required to Implement the Remedy

Additionally, MDEQ may require corrective action under the State-issued Solid Waste Management Permit if a constituent listed in the permit exceeds an MDEQ Tier 1 Target Remediation Goal (TRG) or EPA Drinking Water MCL. Therefore, when evaluating a final remedy, other COCs may be considered. The Final Remedy Selection Report will also be provided to MDEQ for review and comment since MDEQ has jurisdiction over the AMU under the State's Nonhazardous Solid Waste Regulations, though the regulations do not yet adopt the requirements of the CCR Rule.

4.4.1 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a corrective action approach which demonstrates that, based on site conditions, contamination will be reduced through natural physiochemical and/or biological processes in an aquifer. With inorganic chemicals, MNA may occur through physical and chemical means, including dispersion, dilution, sorption, and/or precipitation. Regular monitoring of groundwater for specific indicators of MNA, as well as COCs, is conducted to demonstrate groundwater is attenuating over time.

4.4.1.1 Performance

MNA can be effectively used to reduce inorganic COCs over time. Given that all COCs are thus far within one order of magnitude of the GWPS, upon source control, MNA may prove effective due to the anticipated increase in pH of impacted groundwater to a less acidic and more neutral pH, which impacts mobility of the COCs and is expected to make them less mobile. Also, natural dilution from the inflow of clean upgradient groundwater should result in decreased COC concentrations.

4.4.1.2 Reliability

Because MNA relies on natural processes to reduce COC concentrations, they are inherently reliable. However, monitoring of geochemical conditions would still need to take place to evaluate external factors that can impact these conditions over time.

4.4.1.3 Ease of Implementation

Because there is a groundwater monitoring system already established in the impacted area, MNA is considered the easiest corrective measure to implement. Based on further characterization of the groundwater, additional wells may need to be installed to adequately assess MNA effectiveness; otherwise, natural processes already active at the site are already in place.

4.4.1.4 Safety Impacts

Safety impacts associated with MNA are minimal since an active groundwater monitoring system is already in place, and monitoring is required in order to document their effectiveness, regardless of the corrective measures employed. There are common safety concerns encountered when sampling monitoring wells; however, these concerns are mitigated by using experienced and qualified sampling personnel.

4.4.1.5 Cross-Media Impacts

MNA should not result in any additional cross-media impacts to subsurface soils or surface water. However, because MNA does not prevent migration and generally requires a longer time to achieve desired reductions, groundwater may continue to impact nearby surface water and periodic surface water and sediment monitoring may be necessary to demonstrate that there are no adverse ecological impacts.

4.4.1.6 Exposure Control to Residual Contamination

Since MNA is a passive control strategy, there is no increased risk of exposure to subsurface contamination. However, since MNA does not prevent migration, there is a continued potential exposure pathway to human and ecological receptors at the nearby stream. As discussed in Section 3.5, based on the quality and location of the stream, there are no anticipated impacts to human health and the environment.

4.4.1.7 Time Required to Begin and Complete Remedy

Because a groundwater monitoring system is already in place, as well as procedures for sampling and analysis, there is minimal lead time needed before beginning MNA. There may be a few additional parameters monitored that provide an indication that attenuation is occurring, but these could easily be incorporated into the existing Sampling and Analysis Plan for the site. Although MNA is the quickest corrective measure to employ, it is also expected to take the longest to complete since it allows natural processes to dictate remediation and does not introduce any physical or chemical aids. For all corrective measures addressed, the time for completion will largely depend on how quickly the source of contamination can be controlled, since the CCR release appears to be fairly recent.

4.4.1.8 Institutional Requirements to Implement the Remedy

Upon approval of MNA as a remedy, there is expected to be little time and no permitting required to implement MNA. MDEQ does not address the installation of specific monitoring wells through a permitting mechanism but only requires they be installed in accordance with the Groundwater Monitoring Plan for the site, which has been previously approved. No other permits or authorizations are required by MDEQ. It is expected no more than three (3) months would be required to modify the plan to address any additional well installations or additional parameters to be monitored.

4.4.2 In-Situ Chemical Stabilization

Monitored natural attenuation can be enhanced by the addition of various chemicals to accelerate precipitation or enhance adsorption, thereby reducing migration of COCs by immobilizing the metals. This is often referred to as in-situ chemical stabilization. Reagents such as ferrous sulfate, calcium polysulfide, zero-valent iron, organo-phosphorus mixtures, and sodium dithionate have been evaluated as potentially effective for COCs related to CCR releases. Also, injecting an alkaline solution in the areas of low pH to bring the groundwater back to a more neutral state could help immobilize metals detected due to a release.

4.4.2.1 Performance

In-situ chemical stabilization is a proven technology for reducing the mobility of COC. However, it is particularly effective for stabilizing metals found in soils and sludges, where conditions can be controlled to ensure stabilization remains effective. Stabilization of metals within the groundwater varies based on the different constituents and does not preclude the metals from becoming soluble and mobile again should geochemical conditions in the groundwater change over time. Also, certain reagents may immobilize some COCs but potentially mobilize other COCs. Therefore, a pilot study would be required to determine the effectiveness and amounts of various reagents available for injection. Performance also depends largely on how well the reagent can be dispersed throughout the shallow aquifer.

4.4.2.2 Reliability

Reliability of chemical stabilization is largely dictated by future geochemical conditions in the groundwater and whether sufficient reagent can be supplied throughout the impacted groundwater over extended periods of time. Since stabilization is achieved by altering the geochemical properties in the groundwater, ceasing the control of this environment may allow for natural changes over time that remobilize the COCs.

4.4.2.3 Ease of Implementation

Upon determining an appropriate reagent(s) that effectively immobilizes the COCs, installing any necessary injection wells would not take a considerable amount of time, cost, or effort unless such wells are required on the Mine property, which requires coordination with the Mine.

4.4.2.4 Safety Impacts

Safety concerns with in-situ chemical stabilization are fairly minimal. There are common safety concerns encountered when installing a new injection well; however, these concerns have been examined and addressed as part of past well installations at the site. Also, depending on the reagent used, there are certain chemical handling procedures that would need to be followed to ensure the safety of those deploying the reagent.

4.4.2.5 Cross-Media Impacts

In-situ stabilization introduces new chemicals to the subsurface; however, the reagents generally employed are commonly accepted or acknowledged as having minimal impacts. Many are even pre-approved by state agencies for use. Therefore, no significant impacts are expected to subsurface soils or groundwater.

4.4.2.6 Exposure Control to Residual Contamination

Since in-situ chemical stabilization involves subsurface injection of reagents, there is no increased risk of exposure via the groundwater pathway. Since the stabilization should aid with immobilization of COCs, COCs potentially seeping into the nearby stream may decrease.

4.4.2.7 Time Required to Begin and Complete Remedy

Since in-situ chemical stabilization requires the addition of injection wells, there would be some lead time determining the location and installing such wells. To ensure effective reagents are selected and adequate dispersion can be achieved, pilot testing will likely be required to demonstrate in-situ chemical stabilization is a feasible remediation technology. Conducting pilot testing is expected to take at least one year. Achieving a complete remedy meeting the GWPS could vary greatly depending on how well the reagent disperses through the subsurface groundwater, as well as how effective it is for immobilizing each COC. However, with in-situ chemical stabilization, specific areas of more concentrated COCs can more readily be targeted by installation of injection wells in those areas, which can be more effective at reducing COC concentrations than remediation technologies of a more permanent, immobile nature (e.g., barrier walls, interceptor trenches, etc.).

4.4.2.8 Institutional Requirements to Implement the Remedy

Shallow wells used to inject fluids directly below the land surface are considered Class V Injection Wells. Although they do not require a permit by MDEQ, authorization to proceed with injection must be obtained from MDEQ. It is expected such authorization to proceed with well installation could proceed within six (6) months of submittal of the request.

4.4.3 In-Situ Permeable Reactive Barrier

Permeable Reactive Barriers (PRBs) are barriers constructed in the path of contaminated groundwater flow that are engineered to remove specific contaminants as the groundwater moves through the barrier. The simplest PRBs are typically constructed by excavating a trench that penetrates the saturated zone (i.e., shallow groundwater) and extends to a confining layer below. The trench is then backfilled with media containing reactive material that absorbs or adsorbs the COCs or forms precipitates to help immobilize the COCs. Groundwater can be funneled towards the reactive material to minimize the amount of reactive material required.

4.4.3.1 Performance

PRB has been shown to be effective for removing COCs associated with CCR leachates. However, the groundwater at Choctaw Generation has not been fully delineated to understand the extent and location PRBs would need to be placed to effectively remove COCs.

4.4.3.2 Reliability

Performance of PRBs is generally expected to be reliable. However, concerns exist related to the ability to maintain adequate reactive reagent concentrations over an extended period of time.

4.4.3.3 Ease of Implementation

Since PRBs require construction of a barrier trench, implementation will be more complex, requiring additional time, cost, and effort and could disturb a considerable portion of the site compared to other less intrusive options. However, upon installation, there is no day-to-day operation and maintenance (O&M) costs, since the PRB is a passive remediation technology. Two potentially significant hindrances to implementing PRBs include the lack of available land owned by Choctaw Generation in the direction of groundwater flow and the hilly topography which make access difficult and unpredictable.

4.4.3.4 Safety Impacts

Installing PRBs involves installation of a trench, which entails higher safety risks encountered during the construction phase. Difficulty accessing an appropriate location for the trench is anticipated, as has been encountered installing groundwater monitoring wells around the site. Also, there are many safety precautions that must be taken to perform any activities on the Mine property or near the electric transmission line between the Choctaw Generation and Mine properties. However, upon installation, there should be little to no safety concerns since the PRB does not require routine O&M.

4.4.3.5 Cross-Media Impacts

During initial installation of the PRB care must be taken that excavation of the trench does not compromise the bottom confining layer resulting in a pathway for contaminated groundwater to move vertically and potentially into aquifers used for drinking water. Upon installation, the reactive barrier is expected to accumulate constituent mass, which should keep COCs from impacting other media. Should the reactive barrier need to be removed and replaced, care will need to be taken to properly handle and dispose of the material to avoid cross-media contamination.

4.4.3.6 Exposure Control to Residual Contamination

A PRB treats the groundwater in place, thus limiting exposure to residual contamination. Exposure may be encountered briefly if the reactive material is excavated and replaced but would be temporary in nature. A PRB would likely not be placed between the AMU Basin and the stream based on space constraints; therefore, exposure to any contaminants seeping into the stream may remain, though concentrations should decrease after time upon controlling the release from the AMU.

4.4.3.7 Time Required to Begin and Complete Remedy

Installing a trench for the PRB will require significant engineering and design time up front to ensure the location, depth, fill material, and required construction access are completely addressed. Construction may take a few months to complete; however, upon construction, the PRB is immediately in use. Designing and constructing one or more PRBs is expected to take at least one year. Achieving a complete remedy meeting the GWPS could vary greatly depending on placement of the barrier and time it takes groundwater to move through the barrier. Also, it may make sense to construct a barrier near the more concentrated area of release and use MNA to address periphery exceedances of GWPS, including any exceedances downgradient of the PRB.

4.4.3.8 Institutional Requirements to Implement the Remedy

A permit is not anticipated to be required by MDEQ for construction of the PRB or installation of the trench. If construction would disturb between 1 and 5 acres of land, a Construction Storm Water General Permit would be required, though obtaining such permit does not require prior approval from MDEQ.

4.4.4 Groundwater Extraction via Pumping

Ground water extraction is commonly employed as a corrective measure at sites where hydraulic control is desired in addition to removal of contaminant mass. Groundwater can be removed from the aquifer using traditional vertical extraction wells or using horizontal well systems. Depending on the quality of the water and whether it will be discharged, sent to a local wastewater treatment system, or reused on site will determine if the recovered groundwater must also be treated. If groundwater must also be treated, the groundwater extraction system is commonly referred to as a pump and treat system.

4.4.4.1 Performance

Groundwater extraction via pumping has been widely applied across various sites, including upwards of 800 Superfund sites, successfully providing control of contaminant migration while removing contaminant mass. Vertical wells can be placed such that their radii of influence slightly overlap to provide hydraulic control at the site. Horizontal wells may also be used where the aquifer is continuous and not subject to significant changes in water elevation. Groundwater extraction can also change the direction of groundwater flow in vicinity of the extraction wells, such that pumping can bring downgradient or cross-gradient groundwater towards the well for removal.

4.4.4.2 Reliability

Performance of groundwater extraction wells is considered a reliable means of removing contaminants and can be operated with little oversight other than periodic maintenance and adjustments to pumping frequency and/or rate.

4.4.4.3 Ease of Implementation

Design and pilot testing of a groundwater extraction system requires additional time to implement, though the technology for deploying extraction wells and setting pumps is typically not complicated. However, ensuring sufficient coverage of the impacted groundwater may require installing wells and pumps within the electric transmission right-of-way or on the Mine property, both of which will slow implementation considerably. Due to current water balance issues, Choctaw Generation would likely not be able to store or reuse the recovered groundwater without discharging it. Therefore, this corrective measure would require a modification to their current NPDES permit, and possibly the installation of a treatment system, to allow for a discharge directly to a stream since there is no local/regional wastewater treatment system (or POTW) available.

4.4.4.4 Safety Impacts

Installing a groundwater extraction system involves installation of extraction wells, pumps, and associated control wiring and piping. Potential safety concerns would be encountered with both the installation and maintenance of this system.

4.4.4.5 Cross-Media Impacts

Since extraction wells remove subsurface groundwater through enclosed piping, there is no expected impacts unless leaks are encountered in the piping system, which should be readily observed by visual inspection. This control measure will require discharge to a stream likely requiring some treatment to meet water quality criteria. Water quality criteria for surface water bodies can be more or less stringent than criteria for groundwater, particularly since EPA has only published criteria for a limited number of COCs.

4.4.4.6 Exposure Control to Residual Contamination

Exposure may be encountered as the groundwater is removed, stored, and treated at the site. However, it will be within a controlled environment of adequately trained site workers such that exposure via ingestion, the only anticipated exposure pathway of concern, should not reasonably occur.

4.4.4.7 Time Required to Begin and Complete Remedy

Designing and installing a groundwater extraction system is expected to take at least a year to implement. Given the low levels of COCs, currently within an order of magnitude of their respective GWPS, the effective placement of extraction wells is expected to restore groundwater quality below the GWPS more quickly than passive controls since removal is more aggressive.

4.4.4.8 Institutional Requirements to Implement the Remedy

A permit should not be required by MDEQ for construction of the groundwater extraction system or reuse of recovered groundwater for plant operations. However, if recovered groundwater needs to be discharged, modification to the existing NPDES permit for the site would be required, including an evaluation of antidegradation and evaluation of treatment technologies necessary to meet the permit limits. Applying for and obtaining the permit is expected to take at least a year.

4.4.5 Groundwater Extraction via Interceptor Trench

Groundwater extraction may also be accomplished by installing a trench to intercept contaminated groundwater and pump it for reuse at the site or for treatment (if required) and discharge. The trench is excavated to the bottom confining layer and typically lined along the bottom and downgradient side with HDPE. A drainage pipe, filter fabric, and gravel backfill are placed in the trench with native soils used to backfill to the surrounding surface elevation. The trench is dug in such a way to allow for gravity flow toward a low spot to allow a sump to collect the captured groundwater for removal.

4.4.5.1 Performance

Groundwater extraction via interceptor trench has proven effective, particularly when groundwater impacts are in shallow zones. However, depending on the extent of impacted groundwater, interceptor trenches can allow groundwater to migrate around either end of the trench and do not provide the hydraulic control that extraction via pumping does. Also, due to the variable topography encountered over short distances throughout the site, there is the increasing likelihood of encountering issues with erosion and unstable soils which may adversely impact the trench.

4.4.5.2 Reliability

Groundwater interceptor trenches are an in-situ technology with few mechanical parts other than the pump required to remove groundwater collected in the trench. However, because the trench is installed below ground, if performance declines due to plugging of the gravel backfill or drainage pipe, making repairs becomes cumbersome.

4.4.5.3 Ease of Implementation

Given the rather shallow depth of the contaminated groundwater, an interceptor trench reaching the confining layer below the contaminated groundwater is feasible for the site. However, based on groundwater monitoring results obtained thus far, it appears the trench would need to be installed off-site or otherwise used as a partial remedy to collect groundwater directly north of the AMU at the electric transmission line right-of-way. Regardless, the pronounced changes in topography encountered throughout the site and densely wooded areas are likely to create issues with access, consistent trenching, and stability of the trench upon completion

4.4.5.4 Safety Impacts

Installing an interceptor trench creates significant safety concerns due to the heavy equipment required during construction and anticipated difficulty accessing an appropriate location for the trench, as has been encountered installing groundwater monitoring wells. Also, there are many safety precautions that must be taken to perform any activities on the Mine property or near the electric transmission line between the Choctaw Generation and Mine properties. However, upon installation of the trench, there would only be those safety concerns associated with the wiring and operation of the sump pump.

4.4.5.5 Cross-Media Impacts

Since the trench removes subsurface groundwater through enclosed piping, there is no expected impacts on other media unless leaks are encountered in the piping system, which should be readily observed by visual inspection. This control measure will require discharge to a stream likely requiring some treatment to meet water quality criteria. Water quality criteria for surface water bodies can be more or less stringent than criteria for groundwater, particularly since EPA has only published criteria for a limited number of COCs.

4.4.5.6 Exposure Control to Residual Contamination

Exposure may be encountered as the groundwater is removed, stored, and treated at the site. However, it will be within a controlled environment of adequately trained site workers such that exposure via ingestion, the only anticipated exposure pathway of concern, should not reasonably occur.

4.4.5.7 Time Required to Begin and Complete Remedy

Designing and installing a groundwater interceptor trench is expected to take upwards of two years to implement. Given the low levels of COCs with no clearly defined plume, an interceptor trench would not be effective unless it is placed in a location that will allow the majority of the groundwater to pass through it. Also, there are significant restrictions and impediments that would need to be overcome to access a suitable area for trench construction. Time to achieve the GWPS is expected to be similar to that of the PRB since both are passive in nature and rely on groundwater flow reaching the remediation system.

4.4.5.8 Institutional Requirements to Implement the Remedy

A permit is not anticipated to be required by MDEQ for construction of the interceptor trench. If construction would disturb between 1 and 5 acres of land, a Construction Storm Water General Permit would be required, though obtaining such permit does not require prior approval from MDEQ. However, if recovered groundwater needs to be discharged to the surface, modification to the existing NPDES permit for the site would be required, including an evaluation of antidegradation and evaluation of treatment technologies necessary to meet the permit limits. Applying for and obtaining the permit is expected to take at least a year.

4.5 FINAL REMEDY SELECTION

Selection of the final remedy must comply with the requirements of §257.97 of the CCR Rule. The ACM Report provides a high-level review of those remedies deemed potentially feasible at the site that warrant further consideration during the selection of a final remedy. Although Choctaw Generation is moving forward with engineering controls to remove water from the AMU surface in an effort to minimize any potential release, a final remedy must address efforts necessary to restore groundwater to conditions deemed protective of human health and the environment (i.e., below the GWPS). To fully vet potential remedies per the requirements of the CCR Rule, all sources contributing to groundwater contamination must be determined, including any naturally-occurring sources, and the extent of the contamination and its subsurface movement must be understood.

Possible alternate or contributing sources include the native soils and the lignite seams which extend throughout the Choctaw Generation site and into the adjacent mine. The Mine also stockpiles lignite directly to the north of the site, which is crushed and loaded onto the belt conveyor feeding the boilers at Choctaw

Generation. Lignite and soil contain naturally-occurring metals that are subsequently seen in the ash and could be impacting groundwater. These potential contaminant sources will be investigated during the semiannual period to demonstrate if these alternate sources are impacting groundwater.

Reports describing the progress towards selecting and designing a remedy will be prepared on a semiannual basis, with the first report due December 29, 2019. The reports will address any new monitoring wells and monitoring data potentially impacting the remedy selection, such as additional COCs exceeding GWPS, trends in COCs currently exceeding the GWPS, extent of contamination, other potential contaminant sources, and changes to groundwater flow or geochemistry. The semiannual reports may also summarize those corrective measures under evaluation and any corrective measures that have been added or removed as potential candidates for final remedy, with a brief explanation for each addition and removal.

In selecting the final remedy, Choctaw Generation will consider the following evaluation factors specified in §257.97(c):

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

(i) Magnitude of reduction of existing risks;

(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;

(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;

(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;

(v) Time until full protection is achieved;

(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

(vii) Long-term reliability of the engineering and institutional controls; and

(viii) Potential need for replacement of the remedy.

(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(i) The extent to which containment practices will reduce further releases; and

(ii) The extent to which treatment technologies may be used.

(3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:

(i) Degree of difficulty associated with constructing the technology;

(ii) Expected operational reliability of the technologies;

(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(iv) Availability of necessary equipment and specialists; and

(v) Available capacity and location of needed treatment, storage, and disposal services.

(4) The degree to which community concerns are addressed by a potential remedy(s).

The Final Remedy Report will also specify a schedule for implementing and completing remedial activities within a reasonable period of time taking into consideration the following factors set forth in §257.97(d):

(1) Extent and nature of contamination, as determined by the characterization required under §257.95(g).

(2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under §257.95(h) and other objectives of the remedy.

(3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy.

(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy.

(5) Resource value of the aquifer including:

(i) Current and future uses;

(ii) Proximity and withdrawal rate of users;

(iii) Groundwater quantity and quality;

(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents;

(v) The hydrogeologic characteristic of the facility and surrounding land; and

(vi) The availability of alternative water supplies.

(6) Other relevant factors.

At least 30 days prior to final remedy selection, Choctaw Generation will discuss the corrective measures assessment in a public meeting with interested and affected parties. Choctaw Generation will also ensure the MDEQ has reviewed and approved the final remedy since they also have jurisdiction over solid waste management units, including corrective action for releases from such units.

FIGURES

ECS
ENVIRONMENTAL COMPLIANCE & SAFETY, INC.
P.O. Box 356
Sherman, MS 38869
(662) 840-5945

Choctaw Generation Limited Partnership L.L.L.P.
2391 Pensacola Road
Ackerman, Mississippi

CCR Groundwater Monitoring Wells

Figure 1

Project No.:

Legend:
Monitoring Well MW-7 E=572.62 (top of casing)

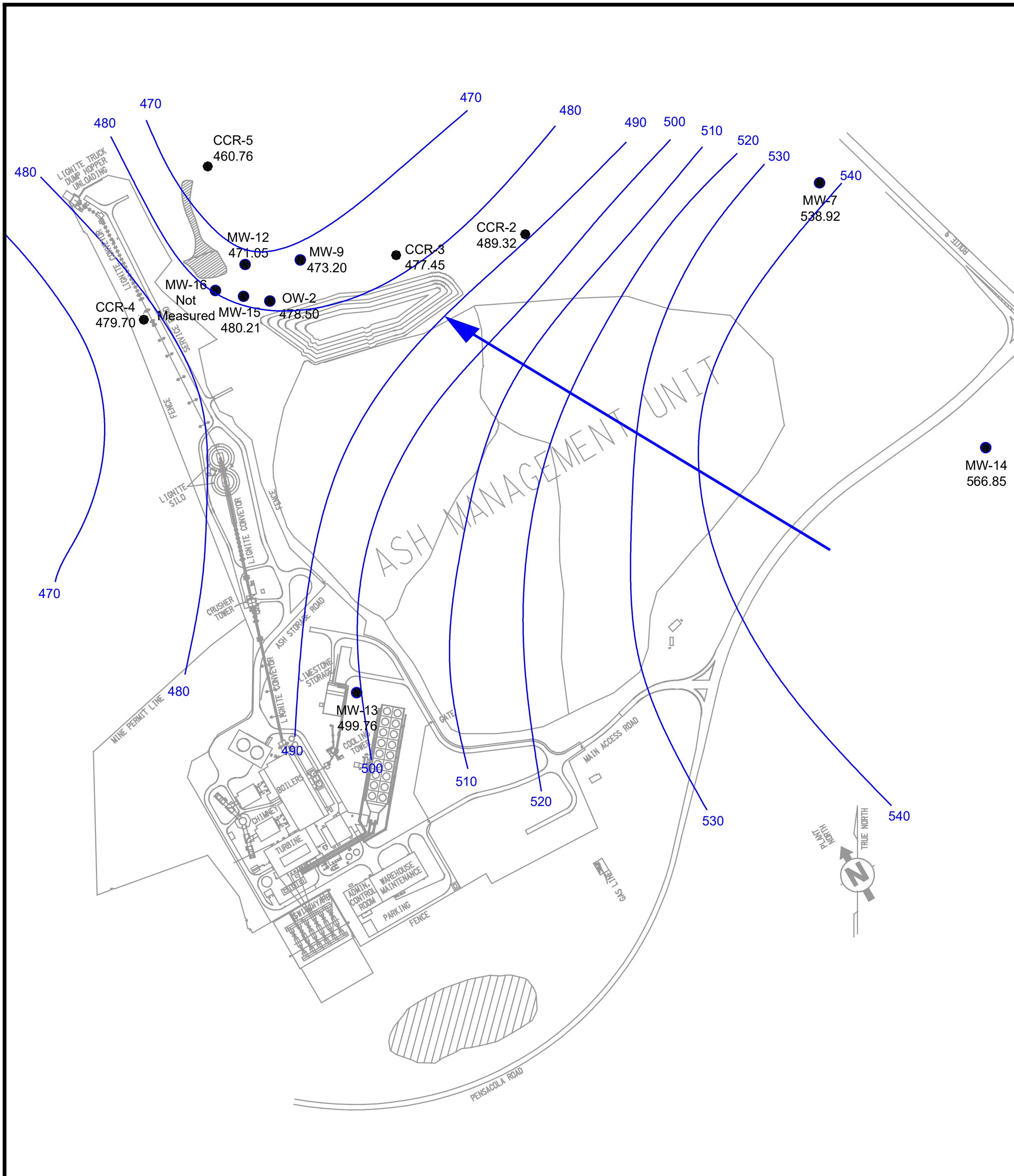
Scale: Not Determined

Drawn By: JTB

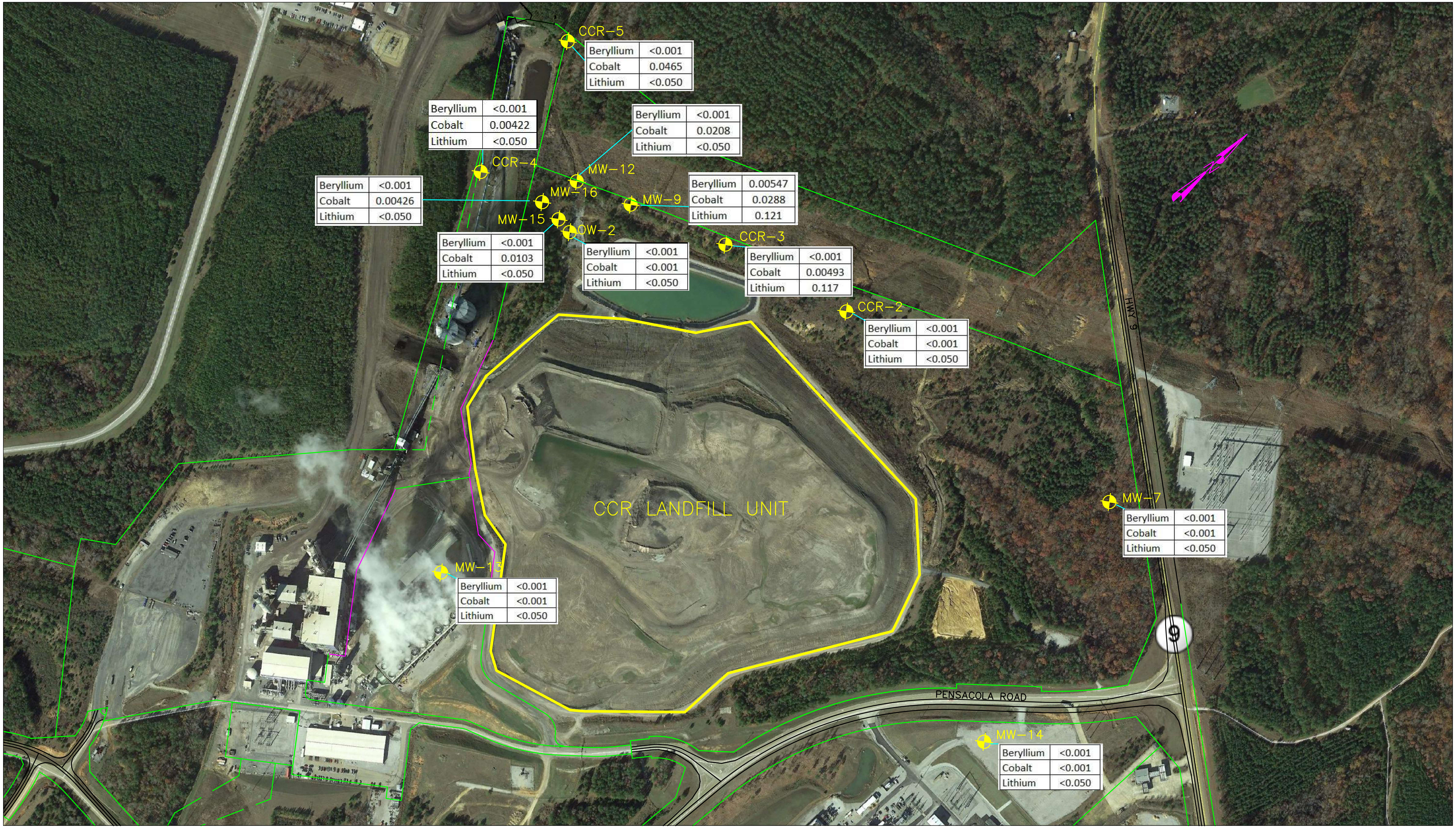
Revised By: JTB; CEB

Date: 8/27/2018

Date: 1/28/2019; 6/19/2019



ECS ENVIRONMENTAL COMPLIANCE & SAFETY, INC. P.O. Box 356 Sherman, MS 38869 (662) 840-5945	Choctaw Generation Limited Partnership 2391 Pensacola Road Ackerman, Mississippi	Legend: Monitoring Well Designation and Groundwater Elevation — MW-7 537.84 Groundwater Elevation Contours (ft) — 500
	Potentiometric Surface Map (March 2019)	Scale: NTS Drawn By: GJL (modified by CEB)
	Figure 2 / Project No.:	Date: 06/19/2019



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2391 Pensacola Road
Ackerman, Mississippi

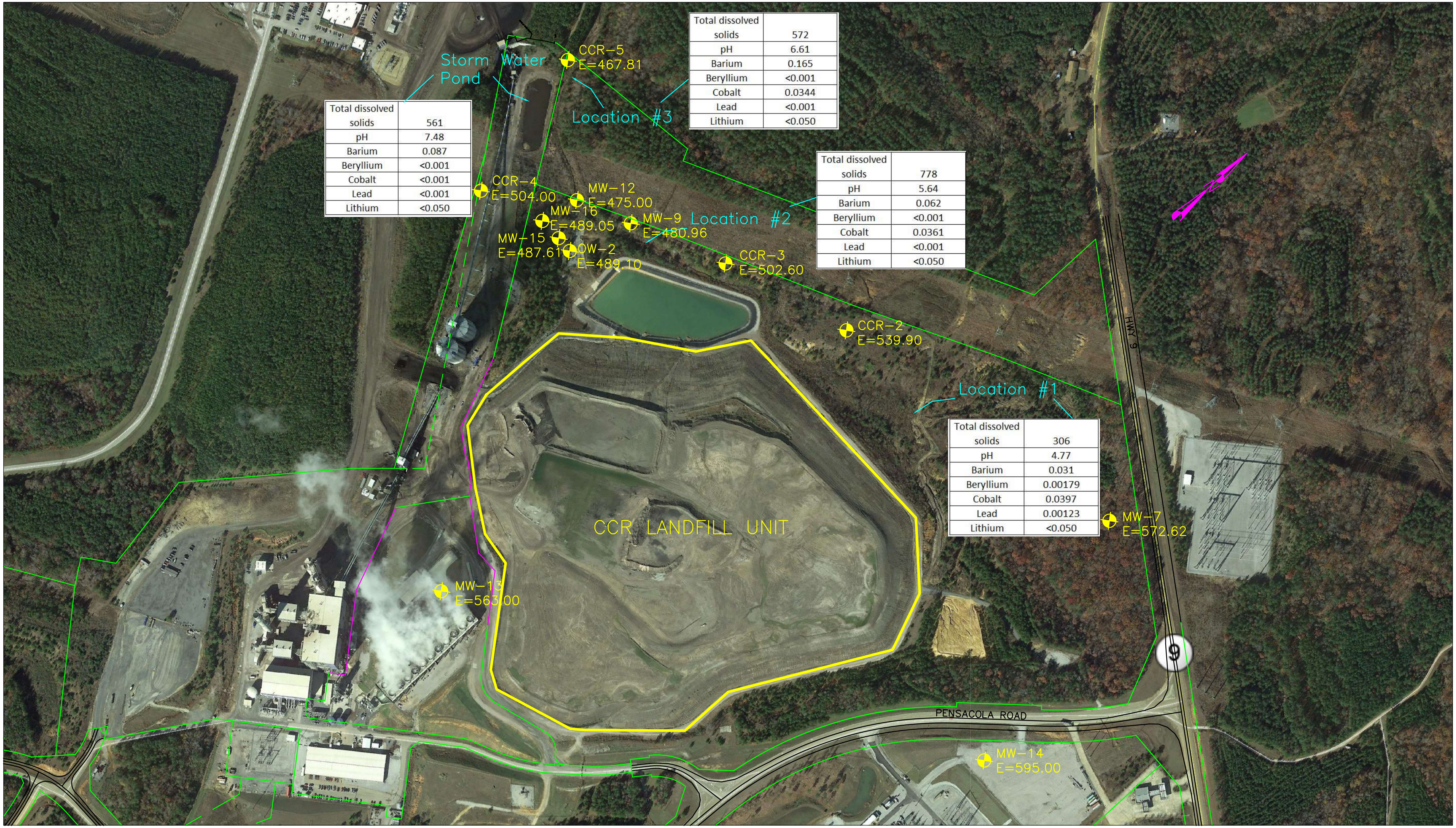
CCR Monitoring Well Results for Three Constituents Exceeding GWPS (March 2019)

Figure 3

Project No.:

Legend:
Monitoring Well MW-7 Table of Results

Scale: Not Determined
Drawn By: CEB
Date: 6/19/2019



Total dissolved solids	561
pH	7.48
Barium	0.087
Beryllium	<0.001
Cobalt	<0.001
Lead	<0.001
Lithium	<0.050

Total dissolved solids	572
pH	6.61
Barium	0.165
Beryllium	<0.001
Cobalt	0.0344
Lead	<0.001
Lithium	<0.050

Total dissolved solids	778
pH	5.64
Barium	0.062
Beryllium	<0.001
Cobalt	0.0361
Lead	<0.001
Lithium	<0.050

Total dissolved solids	306
pH	4.77
Barium	0.031
Beryllium	0.00179
Cobalt	0.0397
Lead	0.00123
Lithium	<0.050

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2391 Pensacola Road
Ackerman, Mississippi

Surface Water Sampling (March 2019)

Figure 4

Project No.:

Legend:
Monitoring Well MW-7 E=572.62 (top of casing)
Location of Surface Water Sample

Scale: Not Determined
Drawn By: CEB
Date: 6/19/2019