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Assessment of Corrective Measures

Richmond Power and Light
Whitewater Valley Station
Richmond, Indiana

GAI Project C151119.22

September 2020

Prepared by: GAI Consultants, Inc.
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Prepared for: Richmond Power and Light
2000 US 27 South
Richmond, Indiana 47374

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1.0 Introduction

This report presents the Assessment of Corrective Measures (ACM) for groundwater impacts identified at the Richmond Power and Light (RPL) inactive surface impoundment (Impoundment) which is a coal combustion residuals (CCR) management unit located at the RPL Whitewater Valley Station (Station) located in Richmond, Wayne County, Indiana (IN; see Figure 1).

1.1 Purpose

Title 40 Code of Federal Regulations (CFR) §257.90 mandates that existing CCR landfills and surface impoundments, also known as CCR units, be subject to groundwater monitoring and corrective action requirements as further detailed in §257.90 through §257.98. These requirements are part of the overall CCR Rule (Rule) which was published in the Federal Register on April 17, 2015 and which became effective on October 19, 2015. The RPL Impoundment was addressed under Section §257.100, which allowed for an exemption from many of the Rule requirements and compliance deadlines.

The Rule was amended on August 5, 2016 and the amendment became effective on October 4, 2016. It amended Section §257.100 by removing the exemptions for inactive CCR surface impoundments. The amendment changed the status of inactive CCR impoundments such that they were treated as other CCR units.

The Station is a coal-fired power plant located in Richmond, Wayne County, IN. The Rule applies to this facility due to the management/disposal of CCR materials that are generated from the combustion of coal. The CCR unit associated with Station operations is the Impoundment used for the management of bottom ash. The CCR unit has a dedicated groundwater monitoring system that was originally installed to comply with IN Department of Environmental Management (IDEM) recommendations and was subsequently evaluated and modified (as needed) for use under the CCR program.

In accordance with §257 Subpart D, GAI Consultants, Inc. (GAI) has prepared this ACM report for the RPL Station Impoundment. As required by §257.96, this ACM report evaluates potential corrective measures to address statistically significant levels (SSLs) of molybdenum at downgradient monitoring well MW-BS associated with the Impoundment. In addition, this report also evaluates potential corrective measures to address cobalt and lithium encountered in a portion of the downgradient CCR wells based on their concentrations compared to IDEM Screening Levels.

This ACM is the initial step in identifying the most viable corrective measure(s) to address groundwater quality as a result of the Impoundment. Further evaluation will be performed, site-specific studies completed, and a final corrective action plan developed and implemented pursuant to §257.97 and §257.98.

This ACM Report and all subsequent reports thereto will be placed in the Station’s operating record per §257.105(h)(1), noticed to the State Director per §257.106(h)(1), and posted to the publicly accessible internet site per §257.107(h)(1).

1.2 Site Description

The Station is located on the south side of Richmond, IN in the southeast quarter of Section 8, T13N, R1W, Wayne County, IN on the west side of US Route 27 (see Figure 1). As shown Figure 1, the Site slopes gently to the south, west, and northwest. Surface drainage follows the topography to an unnamed tributary to the East Fork of the Whitewater River referred to as Dubner’s ditch, and to a swale to the north that drains to the west toward Dubner’s Ditch. Dubner’s Ditch is a steep-sided, southward draining valley located about 500 feet west of the western edge of the Site, that is between about 40 feet and 100 feet lower in elevation than the western edge of the Site. The toe of the dike along the western side of the Site is within about 10 feet of the property line and the toe is along the property line on the northern side of the Site. There is a chain link fence along the property line. The Site layout, including the approximate limits of the impoundment, is shown on Figure 2.

1.3 Site Geology/Hydrogeology

The general Site geology, based on publications by the IN Department of Natural Resources (DNR), indicates that there is an unconsolidated surficial aquifer (Maier, 2011a), referred to as a Till Veneer Aquifer System, which is generally less than 50 feet thick. It is described as a till with intermittent and discontinuous surface and subsurface gravels and sands in places. It is underlain by the Ordovician-age Maquoketa Aquifer System, a bedrock aquifer (Maier, 2011b) composed primarily of shale with some interbedded limestone. It is noted that in most of Wayne County the Maquoketa is overlain by thick clay deposits. A review on water wells (from the DNR website) indicated that considerable drawdown and dry holes are common in both the till and the rock aquifers. Looking at available water well logs on the website, there were a few wells drilled near the top of the hill (along Route 27 to the east of the Site) that were drilled into rock and were considered to be dry in till and in rock. A few wells nearby appear to have encountered water at top-of-rock or in granular layers within the till. Potentiometric surface maps of Wayne County for the unconsolidated aquifers (Schmidt, 2014a) and the bedrock aquifers (Schmidt, 2014b) both show the Site to be on the edge of the available mapping.

Assuming the potentiometric surfaces continue through the Site with the same trends as mapped areas, groundwater flow, in both the unconsolidated and bedrock aquifers, is to the west toward the valley of the Whitewater River. The elevations appear to be about 20 feet higher in rock than in soil. In the text for both maps, it is noted that the aquifers used in the water wells are under confined conditions and that the potentiometric surfaces approximate the overlying topography.

Results of the GAI 2016 groundwater characterization of the Site, the soil aquifer has been determined to consist of an apparently continuous confined, saturated sand or sand and gravel layer on the site located within or at the base of the till. The potentiometric surface slopes generally to the west through the site.

The rock aquifer has been determined to consist primarily of fractured, weathered limestone located within five to ten feet below the top of rock surface. It is saturated and confined by the till except on the southwest corner of the site where it is unconfined in a bedrock high point on the site. The slope of the potentiometric surface is complicated, with a large relatively flat high in the northern half of the site and low areas to the south and northwest.

The soil aquifer is separated from the underlying fractured rock aquifer. This is even shown where TOR is high on the southwest corner of the site by the perched soil aquifer and the underlying unconfined rock aquifer.

Based on the findings presented in this groundwater characterization, GAI propose utilizing only the shallow soil aquifer to monitor the site. This would be accomplished by converting select shallow piezometers to use as groundwater monitoring wells. The rock aquifer piezometers would continue to function as piezometers to monitor groundwater changes over time and would be available for conversion to monitoring wells if in the future it is determined that monitoring the deeper rock aquifer should be conducted.

2.0 Groundwater Monitoring Network

2.1 Existing Groundwater Monitoring System

The Site groundwater monitoring system was established during original interactions with the IDEM regarding the groundwater characterization and was revised during ongoing monitoring for the Site. The Site system, which is shown on Figure 2, is composed of:

- Eight monitoring well (MW) pairs (shallow and deep wells designated as S and D) at locations MW-A through MW-H;

    - Monitoring well MW-GS was found to have insufficient water for monitoring purposes, therefore, a third well, designated as MW-GSR, was installed in its place.
    - It was determined during the characterization that the shallow wells represent groundwater in the uppermost aquifer on Site. That aquifer is a soil aquifer composed of a continuous confined, sand or sand and gravel layer located within the glacial till. The deep wells are drilled into the underlying rock aquifer and are therefore only being used as piezometers.
- Two shallow monitoring wells at locations MW-IS and MW-JS installed as part of an arsenic investigation of MW-H-S.
- Five shallow monitoring wells designated as MW-KS, MW-LS, MW-MS, MW-NS and MW-OS installed offsite on property to the west of the impoundment as part of the ACM characterization.
- Two older, shallow wells designated as MW-1 and MW-2, made of stainless steel that were believed to have been installed as part of a petroleum tank leak investigation.
    - These are only used as piezometers.
- Five staff gauges used to monitor water levels in ponds A-1, A-2, A-3, A-4 and P-4.
- Four piezometers (PZ-1703, 1704, 1705 and 1706) used to monitor water levels near pond A-1 and in ponds P-1, P-2 and P-3 (Pond identifications not designated on Figure 2).
- PZ-1701 and PZ-1702 were abandoned during the coal pile runoff control construction operations.

The monitoring wells at locations A through H were installed in 2016. The monitoring wells at locations IS and JS were installed in 2018. The ACM characterization monitoring wells at locations MW-KS, MW-LS, MW-MS, MW-NS and MW-OS were installed in July 2020.

Figure 3 shows a potentiometric map of the uppermost (soil) aquifer based upon water level readings taken during the last round of Site Characterization samples collected in August 2020.

2.2 Existing CCR Groundwater Monitoring System

The CCR groundwater monitoring system, a subset of the groundwater monitoring system, currently consists of seven wells, including three upgradient wells (MW-AS, MW-FS, and MW-GSR), four downgradient wells (MW-BS, MW-CS, MW-DS, and MW-JS). The screened intervals of the wells monitor the uppermost aquifer on site, a soil aquifer composed of a continuous confined, sand or sand and gravel layer located within or at the base of the glacial till which blankets the site.

In addition, five off-site downgradient monitoring wells (MW-KS, MW-LS, MW-MS, MW-NS and MW-OS) were recently installed as part of on-going groundwater characterization to delineate the extent of the identified release from the CCR unit.

3.0 Groundwater Sampling and Analysis Summary

3.1 Background and Detection Monitoring

Per the requirements of §257.94(b), background sampling to collect a minimum of eight independent samples was conducted from April 2017 through August 2018 from each of the background/upgradient and downgradient wells. Two new wells, MW IS and MW-JS, were installed in March 2018 resulting in only two background samples from MW-IS and three background samples from MW-JS being collected. The wells on site were originally analyzed for the CCR rule Appendix III and Appendix IV parameters in addition to parameters requested by IDEM. In January 2018, the parameter list was reduced to just the Appendix III and Appendix IV parameters. The initial detection monitoring samples for the Appendix III parameters were collected in March 2019.

3.2 Background and Detection Monitoring Results

Background standards were calculated for the Appendix III parameters and during the June 2019 review, it was determined that there were statistically significant increases (SSIs) for one Appendix III parameter in two of the downgradient monitoring wells.

Table 1 presents the parameter and downgradient monitoring wells with identified SSIs.

Table 1
Detection Monitoring Statistically Significant Increases (SSI)

Parameter	Calculated Background Concentration		Downgradient			
		Location ID:	MW-BS	MW-CS	MW-DS	MW-JS
		Sample Date:	3/19/2019	3/20/2019	3/20/2019	3/20/2019
		Units				
Boron, Total	11.3	mg/L	4.9	2.22	6.3	1.3
Calcium, Total	783	mg/L	401	242	371	215
Chloride	371	mg/L	339	68.5	191	31.4
Fluoride	0.17	mg/L	0.25	0.36	0.10	0.14
pH	6.55/7.79	s.u.	7.4	7.3	7.1	7.1
Sulfate	2110	mg/L	1750	931	1130	422
Total Dissolved Solids	3760	mg/L	2540	1480	2130	1100

Note:

Highlighted values indicate SSIs.

mg/L - milligrams per liter

s.u. - standard units

3.3 Assessment Monitoring

The Impoundment was transitioned into the Assessment Monitoring (AM) Program based upon the June 2019 review of the March 2019 Detection Monitoring sampling results. In accordance with the requirements established in the CCR rule, samples are collected from the CCR wells on a semi-annual basis. Groundwater level measurements are also collected from all monitoring wells, piezometers, and staff gauges during sampling events.

AM sampling began in September 2019. Samples were collected and analyzed for all Appendix III and Appendix IV parameters. The second AM sampling occurred in December 2019 and samples were analyzed for the Appendix III parameters and for Appendix IV parameters that were detected during the first AM. The third AM sampling occurred in March 2020 and samples were analyzed for the Appendix III parameters and for Appendix IV parameters that were detect during the second AM.

Groundwater Protection Standards (GPS) were determined for the Appendix IV parameters for samples collected in December 2019 and March 2020. The GPS were developed as the larger of the Maximum Contaminant Level (MCL) or, for parameters without an established MCL, the US Environmental Protection Agency (USEPA) Regional Screening Level (RSL) value and the Site-specific background concentration for each Appendix IV parameter based on a tolerance limit statistical procedure.

Table 2 presents the GPS developed for evaluation of the AM results.

Table 2
Established Groundwater Protection Standards

Chemical Name	Unit	Upper Tolerance Limit (UTL)	Federal Limit	Federal Limit Type	GPS
Antimony, Total	mg/L	0.001	0.006	MCL	0.006
Arsenic, Total	mg/L	0.001	0.01	MCL	0.01
Barium, Total	mg/L	0.125	2	MCL	2
Beryllium, Total	mg/L	0.0002	0.004	MCL	0.004
Cadmium, Total	mg/L	0.00032	0.005	MCL	0.005
Chromium, Total	mg/L	0.002	0.1	MCL	0.1
Cobalt, Total	mg/L	0.0142	0.006	RSL	0.0142
Fluoride	mg/L	0.17	4	MCL	4
Lead, Total	mg/L	0.001	0.015	RSL	0.015
Lithium, Total	mg/L	0.364	0.040	RSL	0.364
Mercury, Total	mg/L	0.002	0.002	MCL	0.002
Molybdenum, Total	mg/L	0.0608	0.1	RSL	0.1
Total Radium	pCi/L	2.207	5	MCL	5
Selenium, Total	mg/L	0.001	0.05	MCL	0.05
Thallium, Total	mg/L	0.001	0.002	MCL	0.002

Notes:

UTL - Upper Tolerance Limit

MCL - USEPA Maximum Contaminant Level

RSL - USEPA Regional Screening Level

GPS - Groundwater Protection Standard

mg/L - milligrams per liter

pCi/L - Picocuries per liter

3.4 Assessment Monitoring Results

Following the initial September 2019 and subsequent December 2019 assessment monitoring sampling events, the downgradient well groundwater concentrations for Appendix IV parameters were compared to the GPSs to determine if a SSL had occurred. In accordance with §257.93, a statistical evaluation of the December 2019 Appendix IV parameters was conducted. For the is evaluation, the lower confidence limits (LCLs) were determined for the Appendix IV parameters for samples collected during the sampling event. Based on a comparison of the calculated LCLs to the GPS, it was determined that there was a SSL) for total molybdenum in downgradient monitoring well MW-BS.

A similar evaluation was conducted after the March 2020 assessment monitoring sampling even. Comparison of the March 2020 LCLs to the GPS also resulted in the determination of an SSL for total molybdenum in downgradient well MW-BS.

For both the December 2019 and March 2020 sampling events, the remaining Appendix IV parameters were not detected at SSLs. Calculated LCLs for the Appendix IV parameters at each downgradient monitoring well along with the comparison to the corresponding GPS is provided in Table 3.

Table 3
Assessment Monitoring Statistically Significant Levels (SSL)

Parameter	GPS	Units	Lower Confidence Limit (LCL)							
			MW-BS		MW-CS		MW-DS		MW-JS	
			Dec. 2019	March 2020	Dec. 2019	March 2020	Dec. 2019	March 2020	Dec. 2019	March 2020
Antimony, Total	0.006	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic, Total	0.01	mg/L	0.001	0.001	0.0006	0.0007	0.001	0.001	0.001	0.0002
Barium, Total	2	mg/L	0.019	0.019	0.0196	0.0199	0.0272	0.0254	0.115	0.121
Beryllium, Total	0.004	mg/L	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Cadmium, Total	0.005	mg/L	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Chromium, Total	0.1	mg/L	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.0015
Cobalt, Total	0.0142	mg/L	0.0015	0.0014	0.0018	0.0018	0.001	0.001	0.001	0.0008
Fluoride	4	mg/L	0.125	0.135	0.219	0.227	0.10	0.10	0.15	0.14
Lead, Total	0.015	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0001
Lithium, Total	0.364	mg/L	0.0815	0.0813	0.0569	0.056	0.0497	0.0496	0.019	0.0208
Mercury, Total	0.002	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Molybdenum, Total	0.1	mg/L	0.119	0.117	0.0967	0.0973	0.0081	0.008	0.0179	0.0176
Total Radium	5	pCi/L	0.845	0.807	0.376	0.382	0.378	0.373	0.910	0.927
Selenium, Total	0.05	mg/L	0.001	0.001	0.0010	0.0023	0.0010	0.001	0.0019	0.0026
Thallium, Total	0.002	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Notes:

GPS - Groundwater Protection Standard

Highlighted values indicate a Statistically Significant Level (SSL)

mg/L - milligrams per liter

pCi/L - Picocuries per liter

Based on the SSL determination detailed above, the Impoundment has been transitioned into the ACM.

3.5 Site Characterization Wells and Sampling

In accordance with §257.95 Subpart G, a field investigation has been initiated by RPL to define the nature and extent of impacted groundwater associated with the CCR Impoundment in the uppermost aquifer. The potential vertical migration and extent of groundwater impacts are limited by the low downward vertical component of groundwater flow because of the underlying low permeability sediments.

RPL has performed the actions required by §257.95 Subpart G, including the installation and development of offsite monitoring wells (MW-KS, MW-LS, MW-MS, MW-NS and MW-OS); collection of soil samples for physical property analysis; water-level data collection; and groundwater sampling and analysis. The five offsite monitoring wells are located west of the Site boundary, as shown on Figure 2. They are classified as down-gradient wells and monitor the first encountered groundwater.

- Wells MW-KS, MS-LS and MW-MS are located on a golf course.
- Well MW-NS is located in an open field owned by RPL.
- Well MW-OS is located in a wooded area on private property.

Monitoring well installation activities were performed in July 2020 by a drilling subcontractor licensed in the State of IN. These monitoring wells were constructed using two-inch ID Schedule 40 polyvinyl chloride (PVC) pipe. An end cap was placed on the base of the PVC pipe. A maximum 10-foot-long section of machined 10-slotted PVC screen was positioned in the well, with solid PVC pipe for the remainder of the well. The PVC pipe extended to just below the ground surface for flush mounted wells and three feet above the ground surface for a stick up. Manufactured filter pack sand was placed from the base of the wells and extend to two feet above the slotted pipe section. A two-foot-thick bentonite pellet seal was placed over the sand layer and hydrated for at least 30 minutes, followed by a high solids bentonite grout extending to approximately 3.5 feet bgs. Concrete was then placed to approximately one-inch above the surrounding ground surface and well pads were formed using trowels. A flush-mounted well cover was incorporated into four of the five well pads and a stick up well cover was used for the fourth well (MW-NS). The PVC riser pipe at each well had an expandable locking end plug installed beneath the cover plate.

Following monitoring well installation, the drilling subcontractor restored project-damaged areas surrounding the individual wells and borings to the general pre-project conditions. This included grading out mounded areas and ruts, as well as spreading straw over the ground surface to promote grass growth.

The wells were developed no less than 24 hours after restoration work was completed by the drilling subcontractor. The wells were developed by use of a bailer for a minimum of one hour each and the water from the well appeared clear. At each well, purge water generated during well development was discharged on the surrounding ground surface after it had passed through filter material. At the golf course locations this purge water was removed from the golf course to the RPL property.

Sampling was conducted on the five new monitoring wells along with two downgradient private supply wells on the adjacent golf course , a potable down-gradient well on an adjacent property , the remainder of the designated CCR wells, and additional down-gradient RPL wells in both July 2020 and August 2020. Groundwater level measurements are also collected from all monitoring wells, piezometers, and staff gauges during sampling events.

3.6 Site Characterization Sampling Results

Review of the preliminary analytical laboratory results from the two site characterization sampling events occurring in July 2020 and August 2020 indicate apparent exceedances of the GPS for several Appendix IV parameters in the newly installed off-site monitoring wells. The following presents a summary of the preliminary results:

- Arsenic was detected at a concentration above the GPS in off-site well MW-OS during the initial July 2020 event. However, the arsenic concentration decreased by an order of magnitude to below the GPS in the August 2020 results. The July 2020 exceedance is interpreted to be the result of relatively high turbidity of the July sample.
- Cobalt was detected at a concentration above the GPS in off-site well MW-OS during the initial July 2020 event. However, the cobalt concentration decreased by an order of

magnitude to below the GPS in the August 2020 results. The July 2020 exceedance is interpreted to be the result of relatively high turbidity of the July sample.

- Lead was detected at a concentration above the GPS in off-site well MW-OS during the initial July 2020 event. However, the lead concentration decreased by an order of magnitude to below the GPS in the August 2020 results. The July 2020 exceedance is interpreted to be the result of relatively high turbidity of the July sample.
- Lithium was detected at a concentration above the GPS in off-site wells MW-KS, MW-LS, MW-MS, and MW-NS during the initial July 2020 event. Results from the July 2020 sampling event are similar; however the lithium concentration was below the GPS in well MW-MS.
- Neither molybdenum nor lithium were detected at concentrations above the GPS in the the nearest downgradient off-site potable well.

Data and statistical evaluation of results from the site characterization sampling are currently ongoing for these two recent sampling events. Based on the preliminary results, it appears molybdenum is attenuating by natural causes within a relatively short distance downgradient of the property boundary. Lithium at concentrations above the GPS appears to extend at least to the newly installed off-site wells but apparently attenuates to below the GPS before reaching the off-site potable well.

4.0 Corrective Measure Options

The ACM must include an analysis of the effectiveness of potential corrective measures in meeting the objectives of the remedy as described under §257.97 and must include an evaluation of the following:

- 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.
- The time required to begin and complete the remedy.
- Institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

Corrective measures objectives specified in §257.97, include:

- Protect human health and the environment.
- Attain applicable GPS.
- Control the source of the release so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents to the environment.
- Remove from the environment as much of the material released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbances of sensitive ecosystems.
- Comply with any relevant standards (i.e., all applicable RCRA requirements) for management of wastes generated by the remedial actions.

Corrective measures options selected for evaluation for potential use at the Site to address SSLs of molybdenum, as well as cobalt and lithium concentrations above the IDEM Screening Levels are described below. These options are anticipated to satisfy the above criteria to varying degrees of efficiency.

Table 4 provides a summary of these technologies and discusses advantages and disadvantages of each technology that should be considered based on Site conditions

4.1 Monitored Natural Attenuation

The USEPA defines monitored natural attenuation (MNA) as follows:

> "The reliance on natural attenuation processes (within the context of a carefully controlled and monitored site clean-up approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods (USEPA 1999). The natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, bioavailability, mobility, volume, or concentration of constituents in soil or groundwater."

MNA is reliant on a detailed understanding of localized hydrogeologic and geologic conditions. A great deal of site-specific data and monitoring over an extended period of time is typically required. MNA is generally not an approach that will lead to rapid closure of a site and is frequently used in combination with other remedies at a site.

Where site conditions are conducive to MNA, it has the potential to provide a more sustainable, lower-cost alternative to aggressive remediation technologies such as pump-and-treat. When properly implemented, MNA successfully removes constituents from groundwater and immobilizes them onto aquifer solids. Any decisions to utilize MNA as a remedy or remedy component should be thoroughly supported by site-specific data and analysis (USEPA 1999, 2015).

According to USEPA (2015) guidance, a four-phase approach should be used to evaluate the likelihood that MNA can be successfully implemented at a given site, and include the following (USEPA 1999, 2007a):

- Demonstrate that the extent of groundwater impacts is stable.
- Determine the mechanisms and rates of attenuation.
- Determine if the capacity of the aquifer is sufficient to attenuate the mass of constituents in groundwater and that the immobilized constituents are stable and will not remobilize.
- Design a performance monitoring program based on the mechanisms of attenuation and establish contingency remedies (tailored to site-specific conditions) should MNA not perform adequately.

Based on MNA case histories for inorganic constituents, MNA timeframes typically range from a few years to decades (EPRI 2015). Because pond closure activities (which could include consolidation and capping) at the Site are projected to take approximately 7.5 years, the timeframe for MNA is compatible with the closure period.

Attenuation mechanisms are generally placed in two broad categories, physical and chemical. Physical mechanisms include dilution, dispersion, flushing, and related processes. All constituents are subject to physical attenuation mechanisms, so physical processes should be considered in MNA evaluations. USEPA (2015) discourages using dilution and dispersion as primary MNA mechanisms, since mechanisms typically disperse contaminant mass rather than immobilize it. In addition, USEPA (2015) advises that dilution and dispersion may be appropriate as a polishing step, such as the boundaries of a plume when source control is complete.

Common chemical mechanisms of attenuation for inorganic constituents include adsorption to, or coprecipitation with, oxides and hydrous oxides (oxyhydroxides) of iron and manganese; iron sulfides such as pyrite (FeS_2), as well as precipitation as carbonates, sulfides, sulfates, and/or phosphates (USEPA 2007b).

Molybdenum and lithium are subject to physical attenuation mechanisms and are also chemically attenuated (e.g., by sorption to naturally occurring oxyhydroxides of iron and other metals, and by coprecipitating with common minerals such as iron sulfides).

4.2 Source Removal and Post-Removal Groundwater Monitoring

Source removal and post-removal groundwater monitoring generally offers an advantage in that no active remediation system requires installation or maintenance. The CCR source material is excavated and removed thus eliminating the source for impacted groundwater. Typically, the groundwater chemistry is still fluctuating following CCR material removal, and there is some uncertainty surrounding how changes in oxidation-reduction potential (redox) may affect contaminant transport. Since this groundwater monitoring remedy with source removal relies on naturally occurring processes that are often hard to predict, there is potential need for future response activities. This approach relies on physical, chemical, and/or biological in situ processes to act without active remediation to reduce the residual constituent concentrations in the groundwater. However, source removal could expedite the reduction in concentrations of contaminants to levels below the GPS. Post-removal groundwater monitoring could commence immediately following source removal utilizing the existing monitoring well network. Monitoring would continue until two consecutive rounds of data are below the GPS.

Source removal is a proven remedy that can be completed using standard construction equipment and has the potential to effectively remove the source of contamination. The excavated materials could be transported off-site for disposal or potentially be permitted for beneficial use. Post excavation confirmation sampling can be employed to demonstrate removal of all source material. Removal of the source material would assist in attaining compliance with GPS at the property boundary and off-site monitoring wells as the source of groundwater impacts would be removed.

Source removal at the scale required for the impoundment would be difficult to successfully implement and could be very costly relative to other alternatives. Some considerations in the implementation of the source removal alternative include the following:

- Large-scale effort potentially resulting in disruption to station operations and community impact.
- Need to identify and receive approval for final disposal location.
- Potential safety concerns during excavation, transportation, and backfilling.
- Dust and other airborne constituent concerns during excavation and transportation.
- Excavation dewatering most likely will be required resulting in management of potentially impacted water.
- Excavation activities are anticipated to take many years.

For this technology to be effective, any residual constituents in the source area need to be separated from potential receptors by a sufficient time of groundwater travel such that naturally occurring processes may effectively reduce contaminant concentrations. Based on the age of the impoundment and the preliminary observed extent of the groundwater impacts downgradient of the site, it appears a sufficient distance exists between the impoundment and the nearest downgradient receptor such that a sufficient reduction in concentrations could be anticipated. dispersion) take effect.

4.3 Hydraulic Containment

Hydraulic containment (groundwater pump and treat) may control potential hazards by eliminating risk pathways or reducing the rate of exposure to acceptable risk levels through containment of impacted groundwater. Effective hydraulic containment uses pumping wells or other subsurface hydraulic mechanisms to create a horizontal and vertical capture zone or a hydraulic barrier.

Hydraulic containment is one of the most mature corrective action technologies. This technology can attain the established remedial objectives because a properly designed and maintained hydraulic containment system can rapidly eliminate offsite migration of impacted groundwater. The effectiveness of the system is highly dependent on the design, installation, operation, and maintenance completed. Significant aquifer and other testing may be required to generate input parameters required for calculations and models used to determine the number and spacing of extraction wells or trenches. Improper spacing of extraction wells due to faulty calculations of capture zones could lead to the installation of inefficient groundwater collection and less than effective hydraulic control.

Implementation of a hydraulic control system could be difficult at the Site given the variable nature of the upper aquifer in regard to thickness and groundwater yield. As mentioned above, extensive testing would most likely be required to evaluate the site-specific effectiveness of this technology. If found to be effective, extracted water could either be reused in beneficial applications or treated, discharged, or reinjected depending on concentrations of constituents.

Hydraulic containment could reduce the downgradient mobility of parameters of concern given a sufficient capture zone can be achieved. The time period to achieve compliance with the GPS at the property border may be relatively short, but system operation may be required for several years if not decades. The system would need to operate as long as source material is leaching contaminants to the groundwater.

Regulatory requirements and institutional controls may be greater for hydraulic containment than some of the other corrective measures. The pump and treat effluent may require treatment for regulatory compliance. Molybdenum and lithium are believed to typically be treated by commonly used ex-situ treatment technologies.

4.4 Physical Containment/Hydraulic Barrier

Physical barriers such as vertical barrier walls and caps are used to isolate the source material and prevent migration of the source water beyond the area of control. For this alternative, a fully encapsulating vertical barrier wall around the impoundment and an associated cap over the extent of the impoundment is proposed. Containment technologies are typically relatively simple to design, can be constructed relatively quickly, and can span over large areas.

The use of physical containment (barrier walls and caps) to isolate impacted materials associated with contaminated sites is a proven technology that has been implemented at thousands of sites. Physical containment typically consists of a slurry wall or other physical barrier constructed below the ground surface to control or restrict groundwater flow. An impermeable barrier would effectively minimize the movement of affected groundwater, providing better protection than remediation relying on physical, chemical, or biological processes. The combination of a vertical barrier wall and impermeable cap could significantly reduce the movement of groundwater through the CCR material and provide sufficient control of off-site migration of contaminants. In order to be effective, the bottom of the barrier should be keyed into the low-permeability soil or bedrock (confining layer) at the bottom of the aquifer, keeping groundwater from seeping beneath it. The clay layer beneath the upper aquifer beneath the site would most likely provide the needed low-permeability layer required for an effective installation.

Although the impoundment would be fully encapsulated under this alternative, groundwater mounding could still occur behind the barrier. In this case, the build-up of hydraulic pressures could result in impacted groundwater escaping the containment through or under the barrier wall. To prevent this from occurring, the design should include funneling of groundwater behind the vertical wall to a low collection point where hydraulic control system would be installed. The hydraulic control system would extract groundwater form behind the barrier wall and transport the water to an on-site groundwater treatment system.

The hydraulic control system established for this technology would be similar to the hydraulic control system discussed above but would generally require greatly reduced flow rates. Lower flow rates would be needed because the system need only to accommodate natural groundwater flow rates, rather than providing a hydraulic barrier. If possible, systems may be designed that could potentially remove the required groundwater from a single collection sump area. Although the pumping rates would be reduced relative to a standalone hydraulic control system, groundwater extraction may need to be performed for an edxtended period of time.

4.5 Permeable Reactive Barrier

A permeable reactive barrier (PRB) wall is the emplacement of chemically reactive materials in the subsurface to intercept impacted groundwater, provide a flow path through the reactive media, and capture or transform the constituents in groundwater to achieve GPS downgradient of the PRB (Powell et al. 1998).

EPRI (2006) provides an overview of PRBs and possible PRB reactive media for constituents from CCR. The PRB is an in-situ technology that allows impacted water to flow through the media and provides a barrier to constituents. PRB can be used to treat groundwater impacted with metals and metalloids. PRB processes used to remediate groundwater are transformation and immobilization. Transformation involves altering a constituent to a less toxic form. Immobilization of constituents occurs through precipitation from the dissolved state or through sorption to reactive media in the PRB (Powell et al. 2002; EPRI 2006).

There are two general designs for PRB walls (ITRC 2005; EPRI 2006):

- Continuous PRBs have reactive media extending across the entire path of the plume, and typically have minimal impact on groundwater flow. They don't necessarily have to be tied to a low hydraulic conductivity unit, although that could prevent constituents from flowing under the PRB if the reactive media permeability was reduced.
- Funnel-and-gate systems incorporate barrier walls to control and direct groundwater flow to the reactive gate. The funnels can be constructed of sheet piles, bentonite, or other barrier wall material. The funnels require installation into a confining bed or low hydraulic conductivity unit to avoid impacted water from flow under the wall. Funnels can also be placed in zones of greatest contaminant mass flow to maximize efficiency of treatment. Funnels can cause a significant increase in groundwater flow velocity, which must be considered in designing the reactive portion of the wall for residence time. The funnel has to extend beyond the extent of the plume to avoid end-around flow.

Site characterization is especially important with PRBs to allow proper design where groundwater flows naturally through the reactive media. A PRB must include the appropriate reactive media and the residence time with the PRB needs to be sufficient to allow for effective treatment. Therefore, it is unlikely that a PRB could be effective if installed at the waste boundary and effectively treat groundwater migrating off the site. Reactive media options are being explored for molybdenum and lithium.

Because PRBs are designed to react passively with groundwater, long term effectiveness may be an issue. Loss of residence time required for proper treatment may become an issue in areas of higher than expected groundwater flow, or loss of treatment capacity due to reactions with impacted groundwater and precipitation of inorganic constituents. Therefore, a PRB may include long term operations and maintenance which could include long periods of down time to replace or replenish spent reactive material.

4.6 In-Situ Stabilization/Solidification

In-Situ Stabilization/Solidification typically uses a crane or excavator mounted auger system to drill into affected soils and uniformly mix the soils with cement to create soil stabilization. Over lapped panels or columns are mixed in place using either an excavator or soil cutter mixer (for the former) or an auger (for the latter). Reagent grouts comprised of Portland cement, slag, and/or bentonite are mixed with the soil in place to improve the durability and reduce the hydraulic conductivity of the treated material. Samples of the freshly treated material or cores of the cured treated material are collected to verify performance criteria have been met.

Alternatively, other appropriate chemical additives are added to chemically bind constituents within the solid matrix. Additional equipment utilized for treatment primarily consists of a grout mixing plant, a grout pump and a mixing rig designed to capsulate constituents in a monolithic solid, thereby minimizing constituent migration. This corrective measure would be anticipated to become effective within a short period following construction. However, in situ stabilization is not typically effective if the source of the COCs is naturally occurring in aquifer materials. Some indirect benefit could still occur if pH is increased in the vadose zone soils.

Benefits of this technology may include the following:

- Increased strength/stability of the treated area.
- Reduce/mitigate contaminant leaching.
- Potentially eliminate the need for excavation of saturated soil.
- Decreased subsurface permeability.
- Potentially reduced dewatering requirements.

In-Situ stabilization is a proven method that is generally easily implemented with readily available equipment and materials. This method could be effective in reducing groundwater impacts relatively quickly if all source material is effectively stabilized. Testing may be required to evaluate the effectiveness of the stabilization and demonstrate the contaminants are no longer leaching.

In-Situ Stabilization/Solidification may be less effective in stabilizing contaminants in fine grained material. Other considerations for this method are space requirements for the large excavators/crane drill systems and ancillary mixing plants and other equipment.

5.0 Remedy Selection

The purpose of this ACM is to begin the process of selecting corrective measures for groundwater impacts based on further evaluation using the criteria outlined in §257.96 Subpart C. The formal remedy selection process, in accordance with the CCR Rule 40 CFR Section 257.97, will begin following submission of the ACM Report. The subsequent remedy selection process will evaluate the following objectives for remedies, as required under Section 257.97(b):

- Protect human health and the environment.
- Attain the COC-specific GWPSs as specified pursuant to Section 257.95(h).
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment.
- 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 (applicable to material releases only).
- Comply with standards for management of wastes as specified in Section 257.98(d).

The corrective measure options described above are potentially feasible remedies, however further data collection and evaluation are required to verify the feasibility of each and provide sufficient information to design a corrective action system that meets the criteria specified in §257.97 Subpart B.

Additional data and analysis will most likely be required to perform a thorough site-specific evaluation to supplement the design of groundwater corrective actions for the Site. The following provides a summary of typical additional data needed to evaluate and select a remedy system:

- Geochemical studies of groundwater and aquifer media.
- Hydrogeologic models or fate and transport calculations.
- Laboratory treatability studies.

- Field pilot studies based on results of laboratory treatability studies and models.

RPL will prepare semi-annual reports to discuss the progress in selecting and designing the remedy in accordance with §257.97 Subpart A. At least 30 days prior to the selection of remedy or remedies, a public meeting to discuss the results of the corrective measures assessment will be held pursuant to §257.96 Subpart E. The final remedy selection report will be developed as outlined in §257.97 Subpart A. Once the remedy has been selected, the implementation of the remedy will be initiated in accordance with §257.98.

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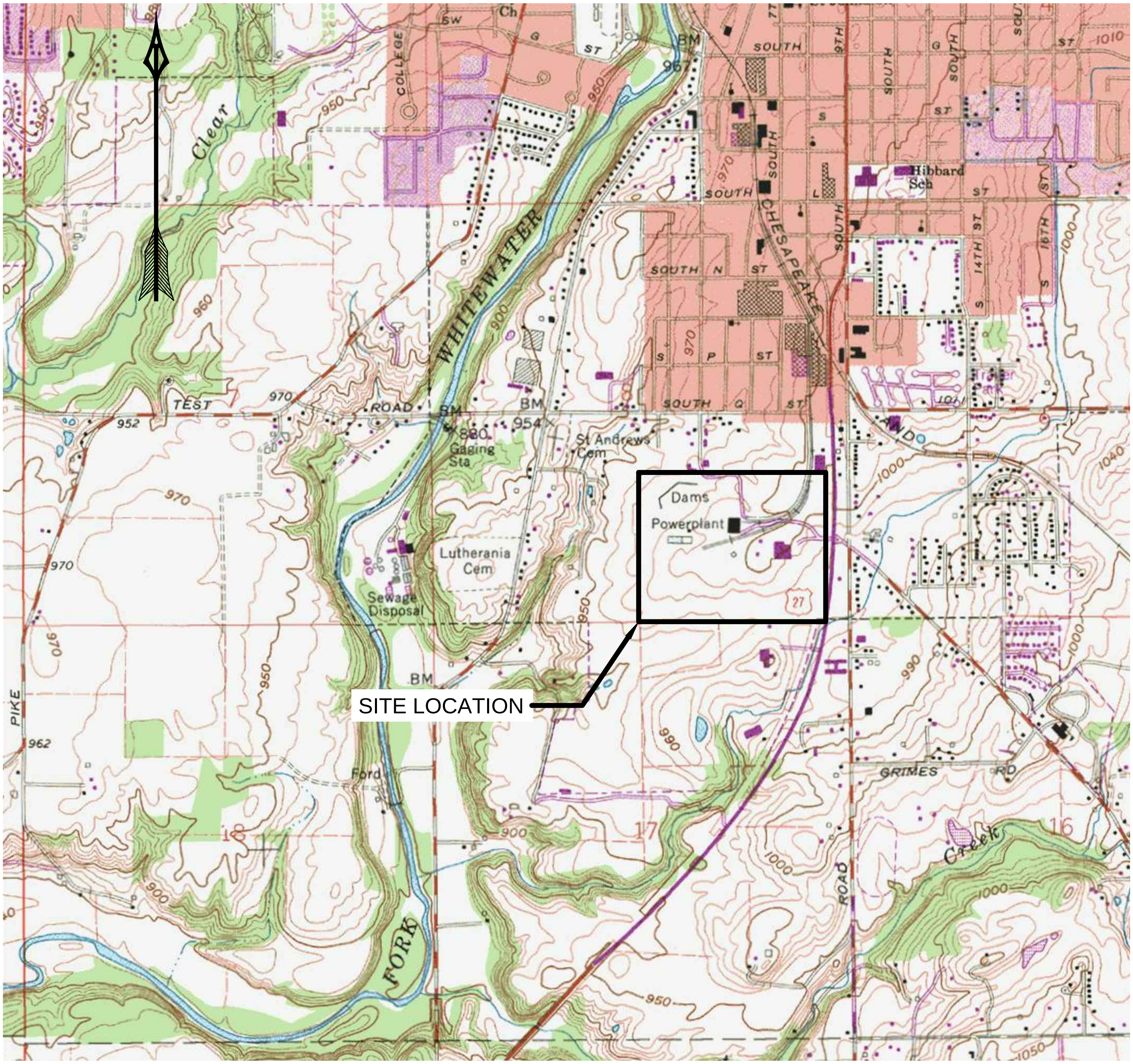
TABLE

Table 4
Summary of Corrective Measure Options
RPL - Whitewater Valley Station Impoundment

Corrective Measure	Description	Performance	Reliability	Ease of Implementation	Potential Impacts	Estimated Time to Implement and Complete Method Installation	Potential Regulatory Requirements
Monitored Natural Attenuation (MNA)	MNA is reliant on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. MNA requires a detailed understanding of localized hydrogeologic and geologic conditions. A great deal of site-specific data and monitoring over an extended period of time is typically required. MNA is generally not an approach that will lead to rapid closure of a site and is frequently used in combination with other remedies at a site. When properly implemented, MNA successfully removes constituents from groundwater and immobilizes them onto aquifer solids.	This measure is proven effective for remediating groundwater	High due to little operations and maintenance needs.	Easy due to minimal additional infrastructure needed to implement remedy.	None anticipated.	Can be implemented quickly. Long-term monitoring will likely be required.	None anticipated.
Source Removal and Post-Removal Groundwater Monitoring	Source removal and post-removal groundwater monitoring generally offers an advantage in that no active remediation system requires installation or maintenance. The CCR source material is excavated and removed thus eliminating the source for impacted groundwater. Typically, the groundwater chemistry is still fluctuating following CCR material removal, and there is some uncertainty surrounding how changes in oxidation-reduction potential (redox) may affect contaminant transport.	This measure is proven effective for remediating groundwater	High due to little operation and maintenance needs.	Easy due to minimal additional infrastructure needed to implement remedy.	None anticipated.	Can be implemented quickly. Varying time for source removal depending on volume and effort.	None anticipated.
Hydraulic Containment	Hydraulic containment (groundwater pump and treat) may control potential hazards by eliminating risk pathways or reducing the rate of exposure to acceptable risk levels through containment of impacted groundwater. Effective hydraulic containment uses pumping wells or other subsurface hydraulic mechanisms to create a horizontal and vertical capture zone or a hydraulic barrier.	This is an effective corrective measure for groundwater constituent remediation provided regular maintenance is performed throughout the operational life. Rebounding can occur after the pumping system is turned off post-remediation.	Medium to high due to system going offline at times for maintenance and repairs.	Moderate due to need for design and installation of hydraulic containment system.	Pumping has potential to impact nearby water supply wells.	System design and associated groundwater modeling could take up to 24 months to complete. Construction of system can generally be completed in 6 months, but depends on scale and complexity.	Hydraulic containment system needs to be compatible with Station NPDES permit.
Physical Containment/Hydraulic Barrier	Physical barriers such as vertical barrier walls and caps are used to isolate the source material and prevent migration of the source water beyond the area of control. For this alternative, a fully encapsulating vertical barrier wall around the impoundment and an associated cap over the extent of the impoundment is proposed. Containment technologies are typically relatively simple to design, can be constructed relatively quickly, and can span over large areas.	This is an effective corrective measure for groundwater constituent remediation. May need to be combined with an additional measure such as a permeable reactive barrier or hydraulic containment.	High due to little operations and maintenance needs.	Moderate due to potential size of barrier.	Will alter groundwater flow beneath and adjacent to the Impoundment.	System design and associated groundwater modeling could take up to 24 months to complete. Construction of system can generally be completed in 6 to 12 months, but depends on scale and complexity.	None anticipated.
Permeable Reactive Barrier (PRB)	A PRB wall is the emplacement of chemically reactive materials in the subsurface to intercept impacted groundwater, provide a flow path through the reactive media, and capture or transform the constituents in groundwater to achieve GPS downgradient of the PRB.	This is an effective corrective measure for groundwater constituent remediation. It is typically only effective for specific constituents.	Medium due to need for reactive media replacement.	Moderately difficult due to potential size and design of barrier and determining suitable reactive media.	Will alter groundwater flow beneath and adjacent to the Impoundment.	System design and associated groundwater modeling could take up to 24 months to complete. Construction of system can generally be completed in 6 to 12 months, but depends on scale and complexity.	None anticipated.
In-Situ Stabilization/Solidification	In-Situ Stabilization/Solidification typically uses a crane or excavator mounted auger system to drill into affected soils and uniformly mix the soils with cement to create soil stabilization. Over lapped panels or columns are mixed in place using either an excavator or soil cutter mixer (for the former) or an auger (for the latter). Reagent grouts comprised of Portland cement, slag, and/or bentonite are mixed with the soil in place to improve the durability and reduce the hydraulic conductivity of the treated material.	This measure has the potential to improve groundwater quality but requires ongoing monitoring to verify effectiveness.	Medium due to potential need to repeat application to prevent rebound.	Easy due to minimal additional infrastructure needed to implement remedy.	Groundwater constituents may be mobilized during treatment process prior to stabilization.	Can be implemented quickly following pilot testing which could take 12 to 24 months to complete. Long-term monitoring will likely be required.	None anticipated.

FIGURES



MAP REFERENCE:
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QUADRANGLE DATED 1960
PHOTO REVISED 1981

SCALE: 1" = 2000'

2000 0 2000 4000

DRAWING TITLE	GAI DRAWING NUMBER:
FIGURE 1 - SITE LOCATION MAP	**A2-001**

PROJECT		GAI FILE NUMBER:		
WHITEWATER IDEM CLOSURE PLAN	gai consultants	**C151119-04-002-001-A2-001**		
		DRAWN BY:	CHECKED BY:	APPROVED BY:
		MAYHOEJ		
CLIENT		SHEET NO.:	SCALE:	ISSUE DATE:
RICHMOND POWER AND LIGHT COMPANY **RICHMOND, INDIANA**		**1 OF 1**	**AS SHOWN**	**08/16/2016**

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ISSUING OFFICE: Pittsburgh | 385 E. Waterfront Drive, Homestead, PA 15120

PLOTTED ON: 8/17/2016 10:38:44 AM PLOTTED BY: William Harris PLOT FILE: GAI.stb

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NO.:	DATE:	DWN:	CHK:	APV:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE

FIGURE 2 - GROUND WATER MONITORING SYSTEM LOCATION MAP

PROJECT

IMPOUNDMENT CLOSURE
WHITEWATER VALLEY STATION
WAYNE COUNTY
RICHMOND, INDIANA 47374

gai consultants

CLIENT

RICHMOND POWER & LIGHT
2000 US 27 SOUTH
RICHMOND, INDIANA 47374

DRAWN BY:	CHECKED BY:	APPROVED BY:
MAYHORJ	TURKARJ	TURKARJ
REVISION	SCALE:	ISSUE DATE:
1	AS SHOWN	08/31/2020
	SHEET NO.:	
	1 OF 1	

GAI FILE NUMBER: **C151119-22-000-000-B2-003**

GAI DRAWING NUMBER: **B2-003**

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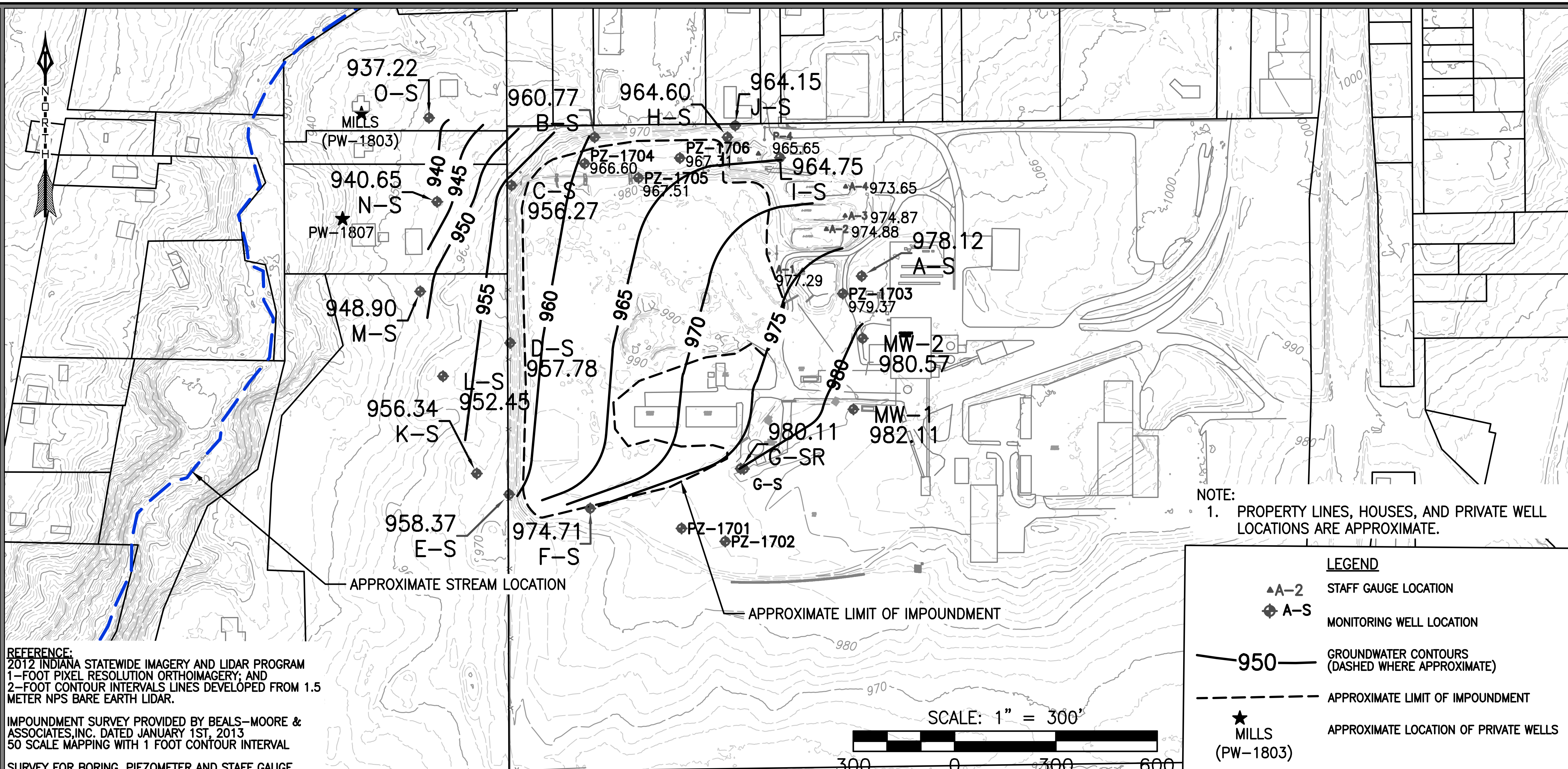
PLOTTED ON: 9/3/2020 9:44:51 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb



REFERENCE:
2012 INDIANA STATEWIDE IMAGERY AND LIDAR PROGRAM
1-FOOT PIXEL RESOLUTION ORTHOIMAGERY; AND
2-FOOT CONTOUR INTERVALS LINES DEVELOPED FROM 1.5 METER NPS BARE EARTH LIDAR.

IMPOUNDMENT SURVEY PROVIDED BY BEALS-MOORE & ASSOCIATES,INC. DATED JANUARY 1ST, 2013
50 SCALE MAPPING WITH 1 FOOT CONTOUR INTERVAL

SURVEY FOR BORING, PIEZOMETER AND STAFF GAUGE LOCATIONS AND ELEVATIONS PROVIDED BY BEALS-MOORE & ASSOCIATES,INC. DATED APRIL 15TH, 2016, SEPTEMBER 27, 2016 AND JULY 10, 2017.

NOTE:
1. PROPERTY LINES, HOUSES, AND PRIVATE WELL LOCATIONS ARE APPROXIMATE.

LEGEND

A-2	STAFF GAUGE LOCATION
A-S	MONITORING WELL LOCATION
950	GROUNDWATER CONTOURS (DASHED WHERE APPROXIMATE)
	APPROXIMATE LIMIT OF IMPOUNDMENT
MILLS (PW-1803)	APPROXIMATE LOCATION OF PRIVATE WELLS

NO.:	DATE:	DWN:	CHK:	APV:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE
FIGURE 3 - POTENTIOMETRIC SURFACE MAP - SOIL - AUGUST 18, 2020

PROJECT
IMPOUNDMENT CLOSURE
WHITEWATER VALLEY STATION
WAYNE COUNTY
RICHMOND, INDIANA 47374

gai consultants

CLIENT
RICHMOND POWER & LIGHT
2000 US 27 SOUTH
RICHMOND, INDIANA 47374

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MAYHOEJ	TURKARJ	TURKARJ
REVISION	SCALE:	ISSUE DATE:
0	AS SHOWN	08/31/2020
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