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**REPORT ON**

# CORRECTIVE MEASURES ASSESSMENT FOR POND 003 NEW MADRID POWER PLANT NEW MADRID, MISSOURI


by
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Cleveland, Ohio


for
Associated Electric Cooperative, Inc.
Springfield, Missouri


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## List of Acronyms and Abbreviations

| Abbreviation | Definition |
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| AECI | Associated Electric Cooperative, Inc. |
| CBR | Closure by Removal |
| CCR | Coal Combustion Residual |
| CIP | Closure in Place |
| COC | Constituent of Concern |
| CMA | Corrective Measures Assessment |
| CSM | Conceptual Site Model |
| FDM | Finite-Difference Method |
| GWPS | Groundwater Protection Standards |
| Gredell | Gredell Engineering Resources Inc. |
| Haley & Aldrich | Haley & Aldrich, Inc. |
| HC | Hydraulic Containment |
| HMOC | Hybrid Method of Characteristics |
| ISS | In-Situ Stabilization |
| Pond 003 | CCR Management Unit |
| MDNR | Missouri Department of Natural Resources |
| MMOC | Modified Method of Characteristics |
| MNA | Monitored Natural Attenuation |
| MOC | Method of Characteristics |
| N&E | Nature and Extent |
| NMPP | New Madrid Power Plant |
| O&M | Operations and Maintenance |
| ONWI | Office of Nuclear Waste Isolation |
| RMS | Root Mean Square |
| RO | Reverse Osmosis |
| SAP | Sampling Analysis Plan |
| SDAP | Statistical Data Analysis Plan |
| SSI | Statistically Significant Increase |
| SSL | Statistically Significant Levels |
| USACE | United States Army Corps of Engineers |
| USEPA | United States Environmental Protection Agency |
| UWL | Utility Waste Landfill |

# 1. Introduction

Haley and Aldrich, Inc. (Haley & Aldrich) was retained by Associated Electric Cooperative, Inc. (AECI) to prepare this Corrective Measures Assessment (CMA) for the Coal Combustion Residual (CCR) management unit identified as Pond 003 located at the New Madrid Power Plant (NMPP). AECI has conducted detailed geologic and hydrogeologic investigations under the U. S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (effective 19 October 2015) and subsequent regulatory revisions (CCR Rule).

This CMA includes a summary of the results of groundwater and site investigations at Pond 003. Groundwater impacted by Pond 003 exceeds the statistically-derived groundwater protection standards (GWPS) for molybdenum at six monitoring well locations surrounding Pond 003 based on statistical analyses completed for an assessment monitoring groundwater sampling event in September 2018. This report evaluates potential corrective measures to address these limited exceedances of the GWPS.

## 1.1 FACILITY DESCRIPTION/BACKGROUND

The NMPP is an active energy production facility that generates electricity through coal combustion (Figure 1-1). The CCR generated are byproducts of the combustion process and include fly ash and boiler slag material. Boiler slag, economizer ash, coal fines, and minor residual waste streams are sluiced from the power generating system to the northern end of Pond 003, where it travels south through maintained channels to the impoundment outlet. Historically, fly ash was also sluiced to this impoundment. Fly ash is now handled in a dry condition and hauled to the on-site Utility Waste Landfill (UWL). The slag is removed from Pond 003 for either beneficial use or disposal in the UWL. Site features are shown on **Figure 1-2**. Suspended economizer ash and coal fines are settled in a channel and stockpiled adjacent to the channel.

## 1.2 SITE CHARACTERIZATION WORK SUMMARY

Extensive subsurface investigations have occurred pursuant to the CCR Rule. In June 2009, a *Stability Evaluation of Slag Pond 1 and Ash Pond 2 Report* was prepared by Geotechnology, Inc. characterized the geology and evaluated stability of Pond 003. In October 2011, a *Hydrogeologic Characterization Report for Coal Ash Impoundment (Unlined)* was prepared by Gredell Engineering Resources, Inc. (Gredell) and characterized the geology and hydrogeology of Pond 003. In January 2012, Gredell prepared a *Well Development and Sampling Summary* that documents the development of the piezometers installed during the Stability Evaluation. In September 2015, an impoundment stability evaluation was conducted by Haley & Aldrich to further assess exterior dikes which frame the perimeter of Pond 003 as a compliance activity associated with the CCR Rule which included borings and cone penetration testing. In September 2016, Haley & Aldrich installed additional monitoring wells surrounding Pond 003 to develop the CCR groundwater monitoring network. Data from these site characterization activities were used to develop a hydrogeologic Conceptual Site Model (CSM), which included:

- Soil borings and sampling;
- Geotechnical testing;
- Well and piezometer installation;
- Slug testing; and

- Groundwater sampling.

The CSM has been further enhanced with ongoing CCR groundwater monitoring and supplemental subsurface investigation activities performed by Haley & Aldrich. Findings from these extensive and updated series of geologic and hydrogeologic investigations have been used to construct a robust CSM that supports the CMA activities discussed in this report.

## 1.3 GROUNDWATER MONITORING

Groundwater monitoring under the CCR Rule occurs through a phased approach to allow for a graduated response (i.e., baseline, detection, and assessment monitoring as applicable) and evaluation of steps to address groundwater quality. Haley & Aldrich prepared a Groundwater Sampling and Analysis Plan (SAP) and a Statistical Data Analysis Plan (SDAP) as required by the CCR Rule. The SAP and SDAP present the design of the groundwater monitoring system, groundwater sampling and analysis procedures, and groundwater statistical analysis methods.

Monitoring wells that make up the Pond 003 groundwater monitoring network were installed in October 2003, April 2009, and September 2016. The Pond 003 groundwater monitoring network includes three background wells (MW-16, B-123, and B-126) and nine downgradient monitoring wells (P-1 through P-5 and MW-6 through MW-9[1]) located around the perimeter of Pond 003. In general, the monitoring wells are screened in the alluvial aquifer zone approximately 50 feet below ground surface.

Detection monitoring sampling events occurred in 2017 and 2018. The results of the sampling events were then compared to background/upgradient concentrations, or natural groundwater values, using statistical methods to determine whether a statistically significant increase (SSI) of constituent concentrations above background concentrations in groundwater had occurred. Results of the detection monitoring statistical analyses completed in January 2018 identified SSI concentrations of Appendix III constituents in downgradient monitoring wells relative to concentrations observed in background concentrations. At the time of this report, no alternative source was identified for the SSI constituents. Accordingly, the groundwater monitoring program transitioned to an assessment monitoring program.

During the Assessment Monitoring phase, CCR groundwater monitoring well samples were collected during May and September 2018 and subsequently analyzed for Appendix IV constituents. Appendix IV analytical results for the baseline and Assessment Monitoring events are summarized in **Table I**.

## 1.4 CORRECTIVE MEASURES ASSESSMENT PROCESS

The CMA process involves development of groundwater remediation technologies that will satisfy the following threshold criteria: protection of human health and the environment, attainment of GWPS, source control, constituent of concern (COC) removal and compliance with standards for waste management. Once these technologies are demonstrated to satisfy these criteria, they are then compared to one another with respect to four balancing criteria: long- and short-term effectiveness, source control, and implementability. The fourth balancing criteria involves input from the community

[1] Note that wells P-5, MW-6, and MW-7 are generally on the upgradient side of the unit with the predominant flow path being towards the east and the river, except when the river rises and causes a temporary reversal of flow to the east.

regarding the proposed remedial activities that will occur in compliance with the corrective measures plan as part of a public meeting. That meeting must be held at least 30 days prior to remedy selection by AECI.

## 1.5 RISK REDUCTION AND REMEDY

The CCR Rule (§257.97(b)(1) - Selection of Remedy) requires that remedies must be protective of human health and the environment. Further, §257.97(c) of the CCR Rule requires that in selecting a remedy, the owner or operator of the CCR unit must consider specific evaluation factors, including the risk reduction achieved by each of the proposed corrective measures. Each of the evaluation factors listed here from §257.97 and discussed in **Section 4** are those that consider risk to human health or the environment including:

- (c)(1)(i) Magnitude of reduction of existing risks;
- (c)(1)(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
- (c)(1)(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;
- (c)(1)(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;
- (d)(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy[2];
- (d)(5)(i) Current and future uses of the aquifer;
- (d)(5)(ii) Proximity and withdrawal rate of users; and
- (d)(5)(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents.

## 1.6 CMA AMENDMENTS

As additional information becomes available in the future, including future groundwater monitoring results or other site-specific or general information, or technological developments, this CMA is subject to change. Nature and Extent evaluations are still underway for the site and may influence the information in this report including the potential corrective measures and the analysis of the potential corrective measures. To the extent material changes to the CMA become necessary, such revised versions of the CMA will be posted to the facility CCR public website.

[2] Factors (d)(4) and (d)(5) are not part of the CMA evaluation process as described in §257.97(d)(4), §257.97(d)(5)(i)(ii)(iv); rather they are factors the owner or operator must consider as part of the schedule for remedy implementation.

# 2. Groundwater Conceptual Site Model

To evaluate potential remedy options, the CSM was developed and evaluated based on data collected and associated with the AECI site. The CSM is summarized below.

## 2.1 SITE SETTING

The NMPP is located approximately two miles east of Marston, Missouri on the western bank of the Mississippi River in New Madrid County, Missouri. The site is located within the northernmost extent of the larger Mississippi Alluvial Plain and is characterized as a relatively flat alluvial plain with extensive agricultural use (Figure 1-1). Pond 003 is a surface impoundment that encompasses approximately 110 acres and is located approximately 0.3 miles southeast of the NMPP power plant site. Pond 003 has ground surface elevations varying from approximately 299 to 320 feet above mean sea level. The western boundary for Pond 003 is the Mississippi River levee which is operated and maintained by the St. Francis Levee District of Missouri and the United States Army Corps of Engineers (USACE).

## 2.2 GEOLOGY AND HYDROGEOLOGY

Geologic and hydrogeologic conditions beneath Pond 003 have been characterized based on information obtained during installation and testing of the monitoring wells installed around Pond 003 in 2009 and monitoring wells installed as part of the CCR groundwater monitoring network in 2016.

### 2.2.1 Site Geology

Pond 003 is located in the Southeastern Lowlands physiographic province. The Southeastern Lowlands is the northernmost extent of the larger Mississippi Alluvial Plain and is characterized by alluvial, fluvial, and deltaic deposits ranging in age from Cretaceous to Holocene. The plant site and Pond 003 are underlain by an unconsolidated alluvium which constitutes a regionally extensive aquifer.

In order from ground surface downward, Pond 003 is underlain by unconsolidated alluvium, the Wilcox Group, the Porters Creek Clay, and the Clayton, Owl Creek, and McNairy formations. Only the Tertiary formations (unconsolidated alluvium, Wilcox group, and Porters Creek group) are described below because they represent the uppermost and regional aquifer system.

Surficial geologic materials in the vicinity of and beneath Pond 003 include alluvium consisting of moderate to poorly sorted clay, silt, sand, and gravel of Holocene age (Miller and Vandike, 1997). The alluvium varies from approximately 250 to 300 feet thick in the vicinity of Pond 003 (Gredell Engineering Resources Inc. [Gredell], 2003). Alluvial sediments were predominantly deposited by the Mississippi and Ohio river systems. The alluvium yields substantial quantities of water to shallow wells, primarily for irrigation use, and is considered the primary local aquifer (Burns & McDonnell, 2006).

The Holocene alluvium is underlain by unconsolidated Tertiary strata. The uppermost Tertiary unit is the Wilcox Group consisting primarily of sand deposits with some interbedded clays and lignites (Burns & McDonnell, 2006). The Wilcox Group is 400 to 500 feet thick at the plant site, lying approximately 250 to 300 feet below ground surface, and stratigraphically overlies the Porters Creek Clay.

The Porters Creek Clay is approximately 650 feet in thickness in the vicinity of Pond 003. The Porters Creek Clay is composed entirely of light grey to black clay (Burns & McDonnell, 2006). The clay is a groundwater flow barrier and barrier to infiltration (Miller and Vandike, 1997). The Porters Creek Clay overlies the Clayton formation. The Clayton formation has a total thickness of approximately 30 feet near the plant site and is comprised of sand and limestone (Burns & McDonnell, 2006).

### 2.2.2 Site Hydrogeology and Hydrology

The water-bearing geologic formation nearest the natural ground surface at Pond 003 is alluvium consisting of moderately to poorly sorted clay, silt, sand, and gravel of Holocene age. The aquifer is used regionally for irrigation and domestic use (although no irrigation or domestic use wells exist adjacent to or downstream of Pond 003). Water levels in the uppermost aquifer are influenced by the Mississippi River stage.

Based on groundwater elevations measured between November 2016 and September 2018, the groundwater gradient in the upper aquifer unit is approximately 0.0008 to 0.003 feet per foot (feet/foot) representative of a very flat gradient. Pond 003 lies adjacent to the Mississippi River and the alluvial aquifer immediately beneath Pond 003 is unconfined and in communication with the river. Seasonal changes in river stage cause the groundwater flow direction to change and occasionally reverse. Due to the influence of the adjacent Mississippi River, the groundwater flow in the alluvial aquifer is generally to the southwest during high river stage and generally to the northeast during typical or lower river stages (Higher river stages generally occur during spring months of the year typically associated with elevated river levels in the Mississippi River). Due to the changing groundwater flow directions, monitoring wells were sited at locations to encircle Pond 003. A select number of those wells (primarily MW-16, B-123, and B-126, and during dominant groundwater flow to the northeast, wells P-5, MW-6, and MW-7) have been designated as upgradient to reflect the dominant groundwater flow towards the river for the majority of the calendar year. Monitoring Well locations are shown on **Figure 2-1**.

Hydraulic conductivity of the uppermost aquifer is based on data collected during slug testing of wells installed during development of the CCR monitoring network. The hydraulic conductivity was calculated to be 75 to 81 feet per day (approximately $3x10^{-2}$ cm/sec).

Because the alluvial aquifer provides a more accessible resource for groundwater production in the area, the Wilcox formation has not been developed locally as a source of groundwater. The clay and lignite present within the Wilcox formation represent lower hydraulic conductivity than the overlying alluvial aquifer. Published hydraulic conductivity values for the Wilcox formation indicate hydraulic in the range of 9 to 25 feet per day (approximately $3x10^{-3}$ to $9x10^{-3}$ cm/sec) (Office of Nuclear Waste Isolation [ONWI], 1982 and Prudic, 1991). The Wilcox formation in the vicinity of Pond 003 is estimated to be approximately 400 to 500 feet thick (Gredell, 2003).

## 2.3 GROUNDWATER PROTECTION STANDARDS

Haley & Aldrich completed a statistical evaluation of groundwater samples using the methods and procedures outlined in the Pond 003 Statistical Data Analysis Plan (Haley & Aldrich, 2019) to develop site-specific GWPS for each Appendix IV constituent.

Groundwater results were compared to the site-specific GWPS. Based on statistical analyses completed in January 2019, statistically significant levels (SSLs) above the GWPS are limited to six monitoring wells

(P-2, P-3, P-5, MW-7, MW-8, and MW-9) and only for one parameter (molybdenum). Monitoring well locations with SSLs are illustrated on Figure 2-2.

## 2.4 NATURE AND EXTENT OF GROUNDWATER IMPACTS

AECI initiated a nature and extent (N&E) investigation as required by the CCR Rule in 2019 and is currently installing a series of supplemental monitoring wells and piezometers (N&E wells) at strategic locations surrounding the impoundment. The N&E wells will be screened in two different, generalized zones of the alluvial aquifer: shallow zone at the uppermost aquifer and deep zone approximately 30 feet below the shallow zone.

Analytical results from the assessment wells indicate that molybdenum concentrations are limited in their extent. In the shallow alluvial aquifer zone, the results from monitoring wells surrounding Pond 003 indicate a dominant groundwater flow to the northeast towards the Mississippi River. The distance of the Mississippi River from the unit ranges from approximately 300 to 400 feet. N&E results will be used to supplement the evaluation of the extent of groundwater impacts, and wells are expected to be sampled in late September and October of 2019. Laboratory results will follow.

# 3. Risk Assessment and Exposure Evaluation

A "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, as a supplement to this CMA document, and is presented in **Appendix A**. The purpose of the risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the NMPP under the CCR Rule. In addition, AECI has voluntarily taken the additional step of evaluating potential groundwater-to-surface water transport and exposure pathways in the risk evaluation.

The risk evaluation report was completed by developing a CSM to identify the potential for human or ecological exposure to constituents that may have been released to the environment. The CSM was used to resolve questions such as: What is the source of constituents? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? If the answers to these questions are 'Yes', then the risk evaluation resolves the question "Are the constituent concentrations high enough to potentially exert a toxic effect?" by comparing constituent concentrations in groundwater to risk-based screening levels.

Screening levels are constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures and ecological exposures. The USEPA and other regulatory agencies, including the Missouri Department of Natural Resources (MDNR), develop screening levels to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists but indicate that further evaluation may be warranted.

The results of the risk evaluation indicate that:

- Groundwater downgradient of Pond 003 is not used as a source of drinking water and is not flowing toward any groundwater supply wells. Therefore, despite some constituents in groundwater being detected at concentrations above GWPS at the waste boundary, the constituents do not pose any health risks associated with drinking water uses or exposures.

- If constituents in groundwater downgradient of the Pond 003 were assumed to flow into the Mississippi River, the concentrations in groundwater would need to be orders of magnitude higher than they are to be a potential concern to people who use the Mississippi River as a source of drinking water and for recreational purposes, and for ecological receptors that live in or use the Mississippi River.

Consequently, the risk evaluation demonstrates that there are no adverse impacts on human health or ecological receptors from groundwater uses resulting from coal ash management practices at Pond 003.

# 4. Corrective Measures Alternatives

## 4.1 CORRECTIVE MEASURES ASSESSMENT GOALS

The overall goal of this CMA is to identify and evaluate the appropriateness of potential corrective measures to prevent further releases of Appendix IV constituents above their GWPS, to remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred, and to restore groundwater in the affected area to conditions that do not exceed the GWPS for these Appendix IV constituents. The corrective measures evaluation that is discussed below and subsequent sections provides an analysis of the effectiveness of five potential corrective measures in meeting the requirements and objectives of remedies as described under §257.97 (also shown graphically on **Figure 4-1**). Additional remedial alternatives were considered but were determined to not be viable for remediating groundwater at this site. This assessment also meets the requirements promulgated in §257.96 which require the assessment to evaluate:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- 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.

The criteria listed above are included in the balancing criteria considered during the corrective measures evaluation, described in **Section 5**.

## 4.2 GROUNDWATER MODELING

A groundwater flow and solute transport model was constructed to evaluate and compare potential corrective measures in support of the CMA for the Site. The numerical model MODFLOW-2005 (Harbaugh, 2005) was selected for the modeling effort and is a three-dimensional, finite difference groundwater flow model capable of simulating the groundwater conditions under various scenarios including pumping and changes to infiltration over time.

Model calibration is the process of refining the model representation of the hydrogeologic framework, hydraulic properties, and boundary conditions to minimize the difference between the simulated heads and fluxes to the measured data. The RMS error is the square root of the average of the squares of the residuals. The RMS adds additional weight to points where the residual is greatest. If the residuals at all points are very similar, the RMS will be close to the mean absolute error. Alternatively, a few points with high errors can add significantly to the RMS for an otherwise well calibrated model. For all three of these criteria the optimal value is zero. The numerical goals for the groundwater flow model calibration are to (1) minimize the ME and MAE errors and (2) achieve the ratio of the root mean square (RMS) error of the head residuals to the range of observed heads (i.e., normalized RMS error) to be at least less than 10 percent (Anderson and Woessner, 1992). Once the groundwater flow model was calibrated to the determined criteria, the model was set-up for solute transport.

Contaminant fate and transport modeling was conducted utilizing the three-dimensional, numerical model MT3DMS (Version 5 of MT3D) (Zheng, 1990). MT3DMS simulates advection, dispersion, adsorption and decay of dissolved constituents in groundwater using a modular structure similar to MODFLOW to permit simulation of transport components independently or jointly. MT3D interfaces directly with MODFLOW for the head solution and supports all the hydrologic and discretization features of MODFLOW. The MT3D code has a comprehensive set of solution options, including the method of characteristics (MOC), the modified method of characteristics (MMOC), a hybrid of these two methods (HMOC), and the standard finite-difference method (FDM). MT3D was originally released in 1990 as a public domain code from the USEPA and has been widely used and accepted by federal and state regulatory agencies.

For this modeling effort, the MT3DMS model utilized the flow regime from the steady-state, calibrated Site groundwater flow model presented above to simulate transport of molybdenum. The steady state model was transformed into a transient model so various CMA options could be evaluated with respect to time. The strength and locations of the potential molybdenum sources specified in the transport models were based on current dissolved-phase concentration distributions from groundwater monitoring data at the Site.

## 4.3 CORRECTIVE MEASURES ALTERNATIVES

Corrective measures can terminate when groundwater impacted by Pond 003 does not exceed the Appendix IV GWPS for three consecutive years of groundwater monitoring [per §257.98(c)(2)]. In accordance with §257.97, the groundwater corrective measures to be considered must meet, at a minimum, the following threshold criteria:

1. Be protective of human health and the environment;
2. Attain the GWPS;
3. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of COCs to the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards (regulations) for waste management.

Each of the remedial alternatives assembled as part of this CMA meet the requirements of the threshold criteria listed above.

The remedial alternatives presented below contemplate both closure in place (CIP) (Alternatives 1 through 4) and closure by removal (CBR) (Alternative 5) of Pond 003. Both closure methods are expressly authorized under the CCR Rule. AECI has prepared a CCR Rule compliant closure plan for Pond 003 and intends to initiate closure of the unit within the allowable timeframes as stated in §257.101 of the CCR Rule.

### 4.3.1 Alternative 1 – Closure in Place with Capping and Monitored Natural Attenuation

Pond 003 would be closed in place with a geomembrane and soil protective cap system to reduce infiltration of precipitation to groundwater thereby isolating source material. This cap selection exceeds regulatory requirements by several orders of magnitude (conservatively, a geomembrane provides permeabilities <1 x $10^{-10}$ centimeters per second (cm/sec) as compared to 1 x 10-5 cm/sec required by the CCR Rule). Over time, depletion of COCs in CCR would allow the concentration of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate. The dissolved phase plume of molybdenum remaining above the GWPS post-closure eventually attenuates, albeit slowly due to the low hydraulic gradient (i.e., the rate at which groundwater moves in the subgrade) in the aquifer underlying Pond 003.

CIP can be completed safely, in compliance with applicable federal and state regulations, and be protective of public health and the environment. In general, CIP consists of re-grading existing CCR and installing a cap system designed to significantly reduce infiltration from precipitation, resist erosion, contain CCR materials, and prevent exposures to CCR. At Pond 003, supplemental design investigations (as required) and engineering design activities along with associated permit pursuits would precede CIP construction activities. Construction of the pond closure is estimated to take approximately 2 years to complete following initiation of closure and are expected to be completed in approximately 2026.

Monitored Natural Attenuation (MNA) is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as “the reliance 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”. 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, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 2015). When combined with a low-permeability cap to address the source by limiting the infiltration of precipitation into and through the CCR, MNA can reduce concentrations of molybdenum in groundwater at the Pond 003 boundary, although the time required to achieve the GWPS would be lengthy due to the low gradient and the resultant groundwater flux.

Following the installation of the cap system, AECI would implement post-closure care activities. Post-closure care includes ongoing cap maintenance and periodic inspections, along with long-term groundwater monitoring until such time that groundwater conditions return to regulatory levels. No post-closure uses are currently planned.

### 4.3.2 Alternative 2 – CIP with In-Situ Stabilization, Capping and Monitored Natural Attenuation

In-situ stabilization (ISS) is a technique that uses mixing of the CCR with amendments to solidify the material in place. Amendments typically include Portland Cement or other reagents and the solidification is completed in-situ using large diameter augers. CCR in Pond 003 that has the potential to periodically come into contact with a fluctuating ground water table due to Mississippi River influence would be isolated by ISS, followed by capping of the surface impoundment. Groundwater impacts would be addressed through the processes of natural attenuation. This alternative would isolate the source (through solidification and installation of a low-permeability cap) and over time, allow the concentrations of COCs in downgradient groundwater to decline and overall groundwater concentrations of COCs to attenuate.

ISS of Pond 003 is predicted to take a number of years to complete, depending on the availability and scheduling of specialized contractors and equipment. Additionally, implementation of ISS will require a detailed design effort with bench scale testing to determine the appropriate amendment mix. Pilot testing will also be needed to verify the ability of equipment to solidify material at depth. ISS has not been commonly used to stabilize entire CCR units as part of a closure strategy, but has been used in larger industry to stabilize materials at depth. Changes to groundwater chemistry associated with the mobility of Appendix IV constituents following completion of ISS, where large volumes of cementitious amendments/reagents are added to the subsurface, are unknown and would require pilot testing. ISS and CIP construction activities are estimated to take approximately 5 years to complete following initiation of closure and are expected to be completed in approximately 2029.

Following the ISS completion and low-permeability final cap system (similar to Alternative 1) installation, AECI would implement post-closure care activities that includes long-term groundwater monitoring and periodic inspections with ongoing cap maintenance.

#### 4.3.3 Alternative 3 – CIP with Capping and Hydraulic Containment through Groundwater Pumping and Ex-Situ Treatment

Pond 003 would be closed in place with a low-permeability cap similar to Alternative 1 to reduce infiltration and isolate source material. Pumping wells would be installed to hydraulically control the downgradient migration of molybdenum. However, pumping wells would generate effluent that would require ex-situ treatment, likely with an ion exchange or a reverse osmosis (RO) treatment system. Both treatment systems are considered advanced stage treatment technologies and require ongoing operation and maintenance and would generate a secondary waste stream – including regeneration/replacement of the ion exchange media or concentration reject water from the RO system. Approvals and permitting would be required for the construction and installation of the treatment systems and discharge of the treated groundwater.

Implementation of a large-scale hydraulic containment (HC) system will require a detailed design effort with bench scale testing to verify groundwater treatment. Pilot testing, such as pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone. While HC is a widely used remediation technology for contaminated industrial/commercial sites, it has not been commonly used as part of a large-scale CCR unit closure strategy. The HC system and associated ex-situ treatment would be planned to be installed during operation of the unit prior to initiation of closure. CIP construction activities are estimated to take approximately 2 years to complete following initiation of closure and are expected to be completed in approximately 2026.

Following the installation of the low-permeability cap, groundwater pumping well network, and ex-situ treatment system, AECI would implement post-closure care activities that includes operation and maintenance of the HC system, long-term groundwater sampling to monitor HC system performance, and cover system maintenance.

#### 4.3.4 Alternative 4 – CIP with Capping and Hydraulic Containment through Groundwater Pumping and Ex-Situ Treatment and Barrier Wall

The configuration of this alternative would be identical to Alternative 3, with the addition of a low-permeability barrier wall between the pumping wells and the Mississippi River. The purpose of the wall is to reduce the flux of groundwater moving downgradient west to east from Pond 003 and minimize the intake of groundwater from the east (the Mississippi River) during groundwater pumping, therefore improving the pumping efficiency of the hydraulic containment system. Approvals and permitting would be required for the barrier wall installation adjacent to the Mississippi River in addition to permits required for discharge of the treated groundwater.

Similar to Alternative 3, implementation of a large-scale hydraulic containment system will require a detailed design effort with bench scale testing to verify groundwater treatment. Pilot testing, such as long-duration pumping tests and additional groundwater modeling, will be needed to verify the hydraulic capture zone. A detailed design will also be required for the barrier wall, given the target depth and horizontal length of the wall. Implementation of the barrier wall and hydraulic containment system will be particularly challenging given the proximity of the Mississippi River and limited work area. Installation of the barrier wall will likely require a variety of permits with work inside the USACE flood levee and near proximity to the Mississippi River. Similar to Alternative 3, the HC system and barrier wall would be planned to be installed during operation of the unit prior to initiation of closure. CIP construction activities are estimated to take approximately 2 years to complete following initiation of closure and are expected to be completed in approximately 2026.

Once implemented, the timeline for active treatment to achieve the GWPS is expected to be potentially shorter than other alternatives due to the enhanced effects of the pumping when combined with a barrier wall.

Following the installation of the low-permeability cap, subsurface barrier wall, groundwater pumping well network, and ex-situ treatment system, AECI would implement post-closure care activities that include operation and maintenance of the hydraulic containment system, long-term groundwater sampling to monitor hydraulic containment system performance, and cap system inspection and maintenance. No ongoing maintenance would be required for the subsurface barrier wall.

### 4.3.5 Alternative 5 – Closure by Removal with Monitored Natural Attenuation

This alternative evaluates the removal of CCR from Pond 003 followed by natural attenuation of molybdenum in groundwater. While this alternative would eliminate the source (ponded CCR) through removal, it takes multiple years to implement during which time the impounded CCR would remain open and subject to ongoing infiltration for the duration of the removal activities. Concentrations of molybdenum in downgradient groundwater would decline via natural attenuation processes once the removal is complete.

Excavated CCR material would likely be disposed on-site, following excavation and removal from Pond 003. The existing UWL would be laterally expanded to accommodate the CCR material removed from Pond 003. Under this scenario, transportation of CCR material over public roadways would be limited to access roads along the existing Mississippi River levee system. AECI already owns and maintains a dedicated haul road from the levee access road to the UWL site. Close proximity of the UWL to Pond 003 would also decrease the duration required for closure, when compared to off-site disposal options.

Ponded CCR materials would be limited in its beneficial use applications. Historically, boiler slag at the AECI facility has been processed at its point of entry into the impoundment for screening and off-site beneficial use. Rejected portions of the boiler slag that did not meet specific criteria remain in Pond 003. Also, fly ash was sluiced and comingled with coal fines and other generated waste streams rendering that portion of the ponded ash less usable. In addition, due to chemical reactions that occurred during the placement of class C fly ash via wet sluicing and the saturated condition of the ponded ash, higher end markets like ready-mix concrete are likely limited. With additional handling and processing (i.e., drying, screening/segregation, etc.), ponded ash can potentially be sourced for cement kiln feedstock and other supplemental beneficial use markets depending on current industry supplies, distance to target markets, competitive market price point, etc. More material characterization and market assessment is required to further evaluate beneficial use potentials for the Pond 003 CCRs.

The technical and logistical challenges of implementing a large-scale ash removal project need to be considered including the removal of CCR with excavations approximately 35-feet deep and CCR removal quantities in excess of 3.6 million cubic yards. Removal activities will be technically challenging and require a comprehensive dewatering and excavation strategy, decant water management, implementation of CCR stabilization methods and temporary staging of material for drying prior to transportation. These aspects of the removal process will affect productivity and must be considered in the planning for the overall removal process and duration. Excavation and construction safety during the removal operation is a major concern due to the use of heavy equipment (bulldozers, excavators, front end loaders, off-road trucks) and trucking/transport operations within the AECI plant site and adjacent to the Mississippi River levee system. Community impacts associated with the use of heavy equipment (equipment delivery, maintenance, etc.) and multi-year truck traffic associated with conveyance of ash removed from Pond 003 and transported to the on-site UWL are also a consideration for this alternative. Based on the volume of material, weather impacts associated with winter and wet weather months, and permitting timeframes associated with construction and operation of the UWL lateral expansions, CBR construction activities are estimated to take approximately 5 to 10 years to complete following initiation of closure and are expected to be completed in approximately 2033.

# 5. Comparison of Corrective Measures Alternatives

The purpose of this section is to evaluate, compare, and rank the five corrective measures alternatives relative to one another using the balancing criteria described in §257.97.

## 5.1 EVALUATION CRITERIA

In accordance with §257.97, remedial alternatives that satisfy the threshold criteria are then compared to four balancing (evaluation) criteria. The balancing criteria allow a comparative analysis for each corrective measure, thereby providing the basis for final corrective measure selection. The four balancing criteria include the following:

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;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

The fourth balancing criterion (i.e. the degree to which community concerns are addressed by a potential remedy) will be considered following a public information session to be held at least 30 days prior to remedy selection.

## 5.2 COMPARISON OF ALTERNATIVES

This section compares the alternatives to each other based on evaluation of the balancing criteria listed above. Each of the balancing criteria consists of several sub criteria listed in the CCR Rule which have been considered in this assessment. The goal of this analysis is to evaluate how each of the remedial alternatives are technologically feasible, relevant and readily implementable, provide adequate protection to human health and the environment, and minimizes impacts to the community.

A color-coded graphic (i.e., ribbons which are part of a comprehensive visual comparison tool (referred to as a stop light table with the comprehensive table is provided as **Table II**) is presented within each subsection below. These ribbons and associated stop light table provide a relative comparative snapshot of the favorability for each alternative against the other alternatives, where green represents favorable, yellow represents less favorable, and red represents least favorable.

### 5.2.1 Balancing Criteria 1 - The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful

This balancing criterion takes into consideration the following sub criteria relative to the long-term and short-term effectiveness of the remedy, along with the anticipated success of the remedy.

#### *5.2.1.1 Magnitude of reduction of existing risks*

As summarized in **Section 3**, no unacceptable risk to human health and the environment exists with respect to Pond 003. In spite of no adverse risk being present, compliance with the CCR Rule requires the evaluation of groundwater remedial alternatives (considered in this CMA) to address SSLs of molybdenum found in groundwater monitoring wells located at the point of compliance around Pond 003. As a result of implementing any of these remedial alternatives, other types of impacts and risks (i.e., the risk of implementing the remedies sometimes referred to as “risk of remedy”) are present to varying degrees.

The remedial alternatives that pose the lowest risk of remedy to human health and the environment are Alternatives 1 (CIP with MNA) and 3 (CIP with HC) as they are implemented on-site and involve the least amount of construction, operations and maintenance activities, the least amount of material removal/large-scale excavation and/or in-situ activities and associated impacts. Alternative 5 (CBR with MNA) has the highest potential impact due to the proximity of Pond 003 to the Mississippi River and levee system, prolonged excavation equipment usage and heavy truck traffic for an extended period of time, which increases the likelihood of roadway accidents during the estimated 5 to 10 years needed to complete material removal. Construction and material transportation will also be required to implement Alternative 2 (CIP with ISS) to support the process of solidifying the CCR. Construction of the treatment system with barrier wall and cap will be required for Alternative 4 (CIP with HC and barrier), along with the management of a generated waste stream, which poses additional risk associated with handling and treatment and the management of treatment byproducts. Comparatively, Alternative 4 (like Alternatives 1 (CIP with MNA) and 3 (CIP with HC)), pose a lesser risk than Alternatives 2 (CIP with ISS) and 5 (CBR with MNA).

| | **Alternative 1**<br>CIP with Cap & MNA | **Alternative 2**<br>CIP with ISS, Cap, & MNA | **Alternative 3**<br>CIP with Cap & Hydraulic Containment | **Alternative 4**<br>CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5**<br>CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria i)*<br>Magnitude of reduction of risks | | | | | |

### *5.2.1.2 Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*

Alternative 5 (CBR with MNA) has the lowest long-term residual risk in that removal of the source material reduces the likelihood of future releases to groundwater. Following the implementation period of this alternative, the CCR material will be disposed in the on-site UWL and managed in accordance with applicable MDNR solid waste permits resulting in a low likelihood of further releases. For Alternatives 1 through 4, Pond 003 would be closed in place with the installation of a low permeability cap that would significantly reduce the infiltration of precipitation into Pond 003, however the CCR would remain in place. Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) also provide additional mitigation measures. Due to CCR remaining in place for Alternatives 1 through 4, these alternatives are considered less favorable as compared to Alternative 5 (CBR with MNA) in terms of the likelihood of further releases following implementation.

| | **Alternative 1**<br>CIP with Cap & MNA | **Alternative 2**<br>CIP with ISS, Cap, & MNA | **Alternative 3**<br>CIP with Cap & Hydraulic Containment | **Alternative 4**<br>CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5**<br>CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria ii)*<br>Magnitude of residual risk in terms of likelihood of further release | | | | | |

### 5.2.1.3 *The type and degree of long-term management required, including monitoring, operation, and maintenance*

Alternatives 1 (CIP with MNA), 2 (CIP with ISS), and 5 (CBR with MNA) are the most favorable alternatives with respect to this criterion because they require the least amount of long-term management and involve no mechanical systems as part of the remedy. Alternatives 1 (CIP with MNA) and 2 (CIP with ISS) will require long-term maintenance of the cover system and sampling during the MNA period. Alternative 5 (CBR with MNA) reduces long-term management at Pond 003, but the transported material will require long-term management at the on-site CCR landfill and groundwater sampling will continue to confirm natural attenuation. The remaining Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) are least favorable because they involve more intensive systems to implement and/or maintain throughout their remediation life cycle, including operation of the pumping wells and an ex-situ treatment system.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria iii)* Type and degree of long-term management required | | | | | |

### 5.2.1.4 *Short-term risks that might be posed to the community or the environment during implementation of such a remedy*

The highest short-term impact posed to the community or environment would be during implementation of Alternative 5 (CBR with MNA), which is considered least favorable. Potential environmental impacts include noise and emissions from heavy equipment, the potential for a release during excavation and construction, and fugitive dust emissions along with associated safety concerns. Community impacts include general impacts to the community due to increased truck traffic on public roads during the entire project duration, including construction of the on-site landfill, along with an increased potential for traffic accidents and fatalities, noise, and truck emissions. In addition, construction adjacent to the Mississippi River levee system has potential to impact levee stability. As noted, Alternative 5 (CBR with MNA) will require a substantial period of time when the CCR material will be open to the environment posing risk during implementation of this remedy.

Alternatives 2 (CIP with ISS) and 4 (CIP with HC and barrier) would include truck traffic to a lesser degree for remedy construction as compared to Alternative 5. The transport of ISS and barrier wall materials to the site make these two alternatives less favorable when compared to Alternatives 1 (CIP with MNA) and 3 (CIP with HC).

For Alternatives 1 (CIP with MNA) and 3 (CIP with HC), risk to the community during implementation is considered the same and would be minimal compared to the other alternatives. Long-term sampling of the monitoring well network to verify treatment system effectiveness will pose no risk to the community.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria iv)* Short term risk to community or environment during implementation | | | | | |

### 5.2.1.5 *Time until full protection is achieved*

There is currently no unacceptable risk to human health and the environment associated with groundwater at Pond 003; therefore, protection is already achieved. Alternatives 1 (CIP with MNA), 4 (CIP with HC and barrier), and 5 (CBR with MNA) are anticipated to take a similar period of time until natural attenuation or active pumping and controls reduce COCs to GWPS concentrations. These three alternatives are considered comparable due to the similar timeframes for achieving GWPS associated with the low hydraulic gradient and/or reduction in flow associated with a barrier.

Alternative 5, (CBR with MNA), could take approximately 5 to 10 years or greater for construction once implementation begins. This timeframe includes the need to construct lateral expansions at the existing on-site CCR landfill. Removal construction would be followed by a period of groundwater monitoring to verify natural attenuation of the groundwater plume. The period for construction is limited mainly by the construction of the on-site CCR landfill expansions, the amount of material that can be handled per day, and the overall volume of CCR to be handled.

Alternative 3 (CIP with HC) improves the timeframe to achieve GWPS by increasing the hydraulic gradient, but the relative overall timeframe as compared to the Alternatives 1 (CIP with MNA), 4 (CIP with HC and barrier), and 5 (CBR with MNA) is not significantly improved to differentiate this alternative.

Alternative 2 (CIP with ISS) could take the longest amount of time due to the potential of reducing permeability of the upper limit of the aquifer as part of stabilization. Implementation of Alternative 2 (CIP with ISS) would require extensive engineering analysis and field testing. Assuming such studies confirm the viability of ISS technology at Pond 003 and equipment availability, field implementation could take a significant amount of time to implement. This would then be followed by a period of groundwater monitoring to verify natural attenuation of the groundwater plume.

Due to the extended time frame that will be required to achieve the GWPS for Alternatives 1 through 5, these Alternatives were given the same ranking for this balancing sub-criterion.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria v)* Time until full protection is achieved | | | | | |

### 5.2.1.6 *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*

Alternatives 1 (CIP with MNA), 3 (CIP with HC), and 4 (CIP with HC and barrier) all have similar, minimal potential for exposure to humans and environmental receptors during regrading and cap construction; monitoring well system installation; and installation of the barrier wall or HC system, respectively.

Alternative 1 (CIP with MNA) is the most favorable alternative since, aside from capping, no additional contact with CCR or impacted groundwater would be needed. A waste stream would be generated from the ex-situ treatment under Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) and would need to be managed either onsite or offsite, which creates a potential for exposure/risk/impacts. Therefore, Alternatives 3 and 4 are considered less favorable when compared to Alternative 1.

Alternatives 2 (CIP with ISS) and 5 (CBR with MNA) have moderate and high potential for exposure, respectively, which makes them the least favorable remedy for this criterion. A high potential for exposure exists during the excavation and transport of the CCR if Alternative 5 (CBR with MNA) is implemented. A moderate potential to exposure exists during ISS construction (Alternative 2) if CCR needs to be disposed in the CCR landfill as part of the preliminary removal effort prior to ISS implementation.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria vi)* Potential for exposure of humans and environmental receptors to remaining wastes | | | | | |

### *5.2.1.7 Long-term reliability of the engineering and institutional controls*

Alternative 5 (CBR with MNA) engineering and institutional controls would have high long-term reliability because the CCR will have been removed from Pond 003 and placed in the existing on-site CCR landfill. With the CCR no longer in place at Pond 003, no additional engineering and institutional controls are anticipated. Alternative 2 (CIP with ISS) is also expected to have a high long-term reliability because the CCR would be isolated within the ISS monolith. Alternatives 2 and 5 are considered favorable when compared to the other alternatives.

Alternatives 1 (CIP with MNA), 3 (CIP with HC), and 4 (CIP with HC and barrier) are all expected to be reliable, as capping and long-term monitoring are common methods for long-term waste management. However, for Alternative 1 (CIP with MNA) the relationship of the remaining CCR to the fluctuating levels of the Mississippi River without hydraulic controls in place could be considered a potential reduction in long-term reliability, making this alternative less favorable. Alternatives 3 and 4 include HC and ex-situ treatment which are considered proven and reliable technologies but still require bench scale and pilot testing and rely on mechanical systems to operate. Therefore, these two alternatives are considered less favorable when compared to Alternatives 2 and 5.

For Alternatives 1 through 4, which include CIP, institutional controls, such as recording of an environmental covenant restricting the use of groundwater can easily be implemented because Pond 003 is located on property owned by AECI.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria vii)* Long-term reliability of engineering and institutional controls | | | | | |



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#### 5.2.1.8 Potential need for replacement of the remedy

Closure in place of Pond 003 with ISS (Alternative 2) and closure by removal (Alternative 5) are both considered permanent and can be effective in appropriate circumstances. Detailed engineering assessments would need to be completed including field pilot testing to confirm the viability of such approaches for Pond 003. From the perspective of needing to replace the remedy, source removal (Alternative 5) is permanent but will take 5 to 10 years to complete once implemented. Since both remedies are permanent, Alternatives 2 (CIP with ISS) and 5 (CBR with MNA) are considered favorable.

Alternatives 1 (CIP with MNA), 3 (CIP with HC), and 4 (CIP with HC and barrier) are expected to have permanent closures with capping in place. The groundwater model results indicate that the GWPS will be achieved by all alternatives. Should long-term monitoring results indicate that the selected remedial alternative is not effective at reducing the concentration of COCs over time (or the rate of achieving the GWPS is significantly slower than the forecasted timeline), alternate and/or additional active remedial methods for groundwater may be considered in the future. This in particular applies to Alternative 1 (CIP with MNA) since no hydraulic controls would be in place making it least favorable in this criterion. A potential exists for the need to replace wells, pumping equipment, and treatment system components for Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier), which make these two alternatives less favorable when compared to Alternatives 2 (CIP with ISS) and 5 (CBR with MNA).

| | **Alternative 1**<br>CIP with Cap & MNA | **Alternative 2**<br>CIP with ISS, Cap, & MNA | **Alternative 3**<br>CIP with Cap & Hydraulic Containment | **Alternative 4**<br>CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5**<br>CBR with MNA |
|---|---|---|---|---|---|
| *Category 1 - Subcriteria viii)*<br>Potential need for replacement of the remedy | (yellow) | (green) | (yellow) | (yellow) | (green) |

#### 5.2.1.9 Long- and short-term effectiveness and protectiveness criterion summary

The following graphic provides a summary of the long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful. Alternative 1 (CIP with MNA) is the most favorable. There is an extended timeframe for all alternatives to meet the GWPS due to the low hydraulic gradient. In addition, Alternative 1 (CIP with MNA) does not include additional treatment technology aside from MNA, and therefore long-term management requirements are minimal. Alternative 1 (CIP with MNA) does not rely on mechanical systems aside from low-permeability capping. Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) provide groundwater treatment at the waste boundary but require additional long-term operation and maintenance, generate a secondary waste stream, and rely on mechanical systems to operate. Alternative 5 (CBR with MNA) includes large-scale construction, and a lengthy implementation period, which adds the potential for exposure to humans and the environment during the construction period. Alternative 2 (CIP with ISS) also includes potential exposure to humans and environment during construction, although the construction duration is expected to be shorter than Alternative 5 (CBR with MNA).

| | **Alternative 1**<br>CIP with Cap & MNA | **Alternative 2**<br>CIP with ISS, Cap, & MNA | **Alternative 3**<br>CIP with Cap & Hydraulic Containment | **Alternative 4**<br>CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5**<br>CBR with MNA |
|---|---|---|---|---|---|
| **CATEGORY 1**<br>Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success | (green) | (yellow) | (yellow) | (yellow) | (yellow) |

### 5.2.2 Balancing Criteria 2 - The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases

This balancing criterion takes into consideration the ability of the remedy to control a future release, and the extensiveness of treatment technologies that will be required.

#### *5.2.2.1 The extent to which containment practices will reduce further releases*

For remedial Alternatives 1 through 4, installation of the low permeability cap will reduce the infiltration of precipitation into Pond 003 and decrease the flux of molybdenum to groundwater over time. Groundwater mounding, and associated outward hydraulic gradient, present at Pond 003 during operation is expected to be reduced during the final operational period and dissipate after closure. Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) are considered favorable because active ex-situ treatment technologies will be implemented to limit further down-gradient migration of molybdenum in groundwater prior to closure.

Under Alternatives 2 (CIP with ISS) and 5 (CBR with MNA), no further releases are anticipated following removal or stabilization of the CCR material. However, the implementation of Alternative 2 (CIP with ISS) is anticipated to require multiple years to complete with MNA monitoring following completion of construction. The potential hydrogeological impacts from a large stabilization project due to alterations to the geochemical conditions from the additives and mixing process differentiate this alternative from Alternative 5 (CBR with MNA).

For Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier), additional containment or treatment practices will address COCs in groundwater migrating downgradient from Pond 003, achieving the performance criteria at the waste boundary. Alternative 1 will not have an additional containment technology beyond natural attenuation making this less favorable in terms of overall containment under this criterion.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 2 - Subcriteria i)* Extent to which containment practices will reduce further releases | | | | | |

#### *5.2.2.2 The extent to which treatment technologies may be used*

No groundwater treatment technologies, other than source isolation through capping and natural attenuation, will be used for Alternatives 1 (CIP with MNA) and 5 (CBR with MNA). There would be no ongoing operation and maintenance of a treatment technology, other than periodic groundwater monitoring. Alternative 1 (CIP with MNA) relies only on low-permeability capping with long-term groundwater monitoring, while Alternative 5 relies on source removal with groundwater monitoring to confirm natural attenuation. Both alternatives are considered favorable for this criterion.

Alternative 2 (CIP with ISS) uses solidification of the CCR below the water table to address COCs in groundwater, which adds to the complexity as compared to Alternative 1 (CIP with MNA). Capping will be required following completion of ISS. Therefore, this alternative is considered less favorable when compared to Alternatives 1 and 5.

Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) will use two additional technologies, hydraulic controls via pumping and ex-situ treatment. Alternative 4 (CIP with HC and barrier) includes an additional technology for the barrier wall. The operation of an ex-situ treatment system will create a secondary waste stream, such as concentrated reject water (RO) requiring off-site disposal, or depleted resin (ion exchange) requiring regeneration or off-site disposal. Due to additional treatment technologies required, these two alternatives are considered less favorable when compared to Alternatives 1 and 5.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 2 - Subcriteria ii)* Extent to which treatment technologies may be used | | | | | |

### *5.2.2.3 Effectiveness of the remedy in controlling the source to reduce further releases summary*

The graphic below provides a summary of the effectiveness of the remedial alternatives to control the source to reduce further releases. Further releases from Alternative 5 (CBR with MNA) will not be addressed until construction is complete, but there is no further potential for release in the long-term making this the most favorable alternative. Alternatives 1 (CIP with MNA), 3 (CIP with HC), and 4 (CIP with HC and barrier) are less favorable either due to the moderate degree of effectiveness in controlling further releases or due to the amount of technologies included. Further releases under Alternative 2 (CIP with ISS) will not be addressed until construction is complete and the complexity of the stabilization makes this alternative less favorable.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| **CATEGORY 2** Effectiveness in controlling the source to reduce further releases | | | | | |

## 5.2.3 Balancing Criteria 3 - The Ease or Difficulty of Implementing a Potential Remedy

This balancing criterion takes into consideration technical and logistical challenges required to implement a remedy, including practical considerations such as equipment availability and disposal facility capacity.

### *5.2.3.1 Degree of difficulty associated with constructing the technology*

CIP with a low permeability cap will be straightforward and can be implemented with common construction methods for Alternatives 1 (CIP with MNA), 3 (CIP with HC), and 4 (CIP with HC and barrier). Typical/Normal construction difficulties are anticipated if Alternatives 1, 3, or 4 are implemented with Alternative 4 being the most complex of these noted alternatives. Specialty equipment or contractors are not required. For Alternative 1 (CIP with MNA), no additional treatment technology is needed other than monitoring wells for groundwater monitoring. Installation of groundwater pumping wells with an ex-situ treatment system (Alternative 3) is expected to be straightforward. Alternative 4 is more complex with the addition of the barrier wall and is considered less favorable.

Alternatives 2 (CIP with ISS) and 5 (CBR with MNA) will be difficult to implement due to technical and logistical challenges. Alternative 5 will include a deep excavation and require the excavation of a substantial volume of CCR materials, dewatering, CCR stabilization, seasonal impacts to construction due to wet weather and winter weather, and transportation. In addition, the excavation of CCR materials proximate to the USACE Mississippi River levee system will require additional diligence and controls to ensure levee stability. For the CCR disposal in on-site lateral expansion of the CCR landfill for Alternative 5 (CBR with MNA), additional effort will be required for the design, permitting, approval, and construction. Under Alternative 2 (CIP with ISS), the successful completion of ISS to target depths will be technically challenging and will require field pilot testing to confirm equipment reach and stabilizing mix. Stabilization work adjacent to the levee system also has a high degree of difficulty, but overall has less material movement when compared to Alternative 5 (CBR with MNA). Alternatives 2 and 5 will both include large-scale construction, extensive permitting, specialty equipment and contractors, longer project durations, and significant technical challenges. Therefore, these Alternatives 2 and 5 are least favorable when compared to Alternatives 1, 3, and 4.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 3 - Subcriteria i)* Degree of difficulty associated with constructing the technology | | | | | |

### *5.2.3.2 Expected operational reliability of the technologies*

Alternative 1, (CIP with MNA) is considered the most favorable from an operational perspective because capping with MNA has a proven track record and requires limited O&M. While alternative 2 (CIP with ISS) is a proven technology and isolates the ponded material, pilot testing would be required to ensure ISS will be able to solidify CCR at depth. The potential for geochemical impact on the groundwater aquifer from the solidification amendments would need to be evaluated. Assuming successful implementation, ISS is also expected to be operationally reliable and is considered favorable. Alternative 5 (CBR with MNA) is considered a reliable alternative as all CCR material would be removed, although implementation would be challenging. Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) are expected to be reliable but will utilize additional groundwater treatment technologies that will require significant O&M and will rely on mechanical systems to operate. Therefore, Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) are considered less favorable.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 3 - Subcriteria ii)* Expected operational reliability of the technologies | | | | | |

### *5.2.3.3 Need to coordinate with and obtain necessary approvals and permits from other agencies*

Alternative 1, (CIP with MNA), is the most favorable since the implementation of the remedy is straightforward and only includes capping and MNA with minimal permitting needs. Alternatives 2 (CIP with ISS) and 4 (CIP with HC and barrier) will require extensive permitting for large-scale construction in below grade soils adjacent to the levee system) and are considered least favorable.

Alternative 5 (CBR with MNA) also will require permitting for the excavation of CCR adjacent to the levee system. The associated lateral expansion of the existing CCR landfill will require a moderate amount of regulating agency interaction, but a solid waste permit already exists for the UWL expansions. The agency will need to approve the construction efforts of the lateral expansions. This alternative is considered less favorable when compared to Alternative 1 (CIP with MNA).

Additional approval and permitting may be required for Alternative 3 (CIP with HC) for the construction and installation of treatment systems and discharge of treated groundwater, but not to the extent contemplated for Alternatives 2 (CIP with ISS) and 4 (CIP with HC and barrier).

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 3 - Subcriteria iii)* Need to coordinate with and obtain necessary approvals and permits from other agencies | [green] | [red] | [yellow] | [red] | [red] |

### 5.2.3.4 *Availability of necessary equipment and specialists*

Alternative 1, (CIP with MNA), is the most favorable since specialty equipment and specialists will not be required to implement the capping or MNA remedy. Alternative 3 (CIP with HC) also consists of well understood and routine treatment systems. Alternative 4 (CIP with HC and barrier) also includes well understood and routine treatment systems but does require the availability of necessary equipment for the barrier wall construction, so this alternative is less favorable than Alternatives 1 and 3.

Alternatives 2 (CIP with ISS) and 5 (CBR with MNA) are the least favorable since both will require specialty remediation contractors to implement full removal or ISS, respectively, which will include large-scale construction dewatering and effluent management and treatment, deep excavations adjacent to the river and levee system, transportation of material for disposal, and implementation of ISS at depth (for Alternative 2 only). These two alternatives are considered the least favorable.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 3 - Subcriteria iv)* Availability of necessary equipment and specialists | [green] | [red] | [green] | [yellow] | [red] |

### 5.2.3.5 *Available capacity and location of needed treatment, storage, and disposal services*

Since Pond 003 will be closed in place for Alternatives 1 through 4, storage and disposal services for CCR material will not be needed. Temporary stockpiling of CCR during regrading and capping can be completed within the current boundaries of the CCR unit. Alternative 1 (CIP with MNA) is the most favorable alternative since no active treatment is needed. Likewise, Alternative 2 (CIP with ISS) does not require any treatment or disposal capacity. It is assumed that any excavated/relocated CCR for the ISS construction would be used in developing final grades of the closure in place. If needed, the existing CCR landfill has capacity to dispose of any necessary CCR materials. Amendments such as Portland Cement will be imported to solidify the material in-situ, with the expectation that Portland Cement will be readily available.

Both Alternatives 3 (CIP with HC) and 4 (CIP with HC and barrier) require treatment systems which do not currently exist at the facility. The ex-situ treatment system may generate a concentrated waste stream which would require onsite treatment or off-site transportation and disposal that the other alternatives would not require. With the treatment system waste stream, Alternatives 3 and 4 are considered less favorable when compared to Alternatives 1 and 2.

Alternative 5 (CBR with MNA) required an evaluation of available capacity at existing CCR landfill. The existing on-site landfill was designed and permitted to manage ongoing production at the NMPP and not ponded CCR material. For Alternative 5 (CBR with MNA), new lateral expansions of the on-site landfill would need to be designed, constructed, and approved since the existing on-site landfills were designed and permitted to manage production needs of the NMPP. Alternative 5 is considered less favorable than Alternatives 1 and 2 since it requires extensive handling, and disposal management of CCR.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| *Category 3 - Subcriteria v)* Available capacity and location of needed treatment, storage, and disposal services | | | | | |

### 5.2.3.6 *Ease or difficulty of implementation summary*

The color ribbon below provides a summary of the ease or difficulty that will be needed to implement each alternative. Alternative 1 (CIP with MNA) is the most favorable, while Alternatives 3 and 4 are considered less favorable with moderate degrees of difficulty in implementing the remedy. Alternatives 2 and 5 have significant degrees of difficulty related to large-scale construction and permitting and are therefore considered least favorable.

| | **Alternative 1** CIP with Cap & MNA | **Alternative 2** CIP with ISS, Cap, & MNA | **Alternative 3** CIP with Cap & Hydraulic Containment | **Alternative 4** CIP with Cap & Hydraulic Containment & Barrier Wall | **Alternative 5** CBR with MNA |
|---|---|---|---|---|---|
| **CATEGORY 3** The ease or difficulty of implementation | | | | | |

# 6. Summary

This Corrective Measures Assessment has evaluated the following alternatives:

- Alternative 1: CIP with low permeability capping and MNA;
- Alternative 2: CIP with ISS, low permeability capping and MNA;
- Alternative 3: CIP with low permeability capping, HC of groundwater through groundwater pumping, and ex-situ groundwater treatment;
- Alternative 4: CIP with low permeability capping, HC of groundwater through groundwater pumping, ex-situ groundwater treatment, and barrier wall; and
- Alternative 5: CBR with MNA.

In accordance with §257.97, each of these alternatives has been evaluated in the context of the following threshold criteria:

- Be protective of human health and the environment;
- Attain the GWPS;
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of COCs to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards (regulations) for waste management.

In addition, in accordance with §257.96, each of the alternatives has been evaluated in the context of the following balancing criteria, noting that these balancing criteria consider the sub-criteria evaluation factors of §257.97(c):

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- 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.

This Corrective Measures Assessment, and the degree to which public comments are addressed, will be used to identify and select a final corrective measure for implementation at Pond 003. AECI understands that risk assessment evaluations confirm that Pond 003, even prior to closure, presents no unacceptable risk to human health or the environment. Therefore, since no adverse risk currently exists to human health and the environment, implementation of any of the remedies must consider the risk incurred during the implementation of the potential remedy activities.

In accordance with §257.98, AECI will implement a groundwater monitoring program to document the effectiveness of the selected remedial alternative. Corrective measures are considered complete when monitoring reflects groundwater downgradient of Pond 003 does not exceed Appendix IV GWPS for three consecutive years. USEPA is in the process of modifying certain CCR Rule requirements and, depending upon the nature of such changes, assessments made herein could be modified or supplemented to reflect such future regulatory revisions.

## References


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**TABLES**

**TABLE I**
**SUMMARY OF ANALYTICAL RESULTS**
Corrective Measures Assessment
AECI New Madrid Power Plant
New Madrid, Missouri

| Location | | Sample Date | USEPA Appendix IV Constituents | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Antimony, Total mg/l | Arsenic, Total mg/l | Barium, Total mg/l | Beryllium, Total mg/l | Cadmium, Total mg/l | Chromium, Total mg/l | Cobalt, Total mg/l | Lead, Total mg/l | Lithium, Total mg/l | Molybdenum, Total mg/l | Selenium, Total mg/l | Thallium, Total mg/l | Mercury, Total mg/l | Fluoride, Total mg/l | Radium-226 & 228 Combined pCi/L |
| | | *Site GWPS* | *0.006* | *0.010* | *2.0* | *0.004* | *0.005* | *0.100* | *0.006* | *0.015* | *0.040* | *0.100* | *0.050* | *0.002* | *0.002* | *4.0* | *5* |
| Up Gradient | MW-16 | 11/2/2016 | <0.0010 | **0.0026** | **0.773** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.026** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **1.22** | **1.85** |
| | | 12/9/2016 | <0.0010 | **0.0029** | **0.783** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.027** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **1.37** | **0.98** |
| | | 1/7/2017 | <0.0030 | **0.0027** | **0.800** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.033** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.10** | **2.34** |
| | | 1/30/2017 | <0.0030 | **0.0026** | **0.730** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.55** | **1.78** |
| | | 2/21/2017 | <0.0030 | **0.0025** | **0.760** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.18** | **1.16** |
| | | 3/28/2017 | <0.0030 | **0.0025** | **0.760** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.44** | **2.33** |
| | | 4/27/2017 | <0.0030 | **0.0025** | **0.760** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.38** | **1.84** |
| | | 5/18/2017 | <0.0030 | **0.0027** | **0.750** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.033** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.59** | **1.93** |
| | | 6/24/2017 | <0.0030 | **0.0020** | **0.720** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.18** | **1.79** |
| | | 8/15/2017 | <0.0030 | **0.0021** | **0.700** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.033** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **1.27** | **1.4** |
| | | 5/30/2018 | <0.0030 | **0.0020** | **0.72** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.025** | **0.0045** | <0.0010 | <0.0010 | <0.00020 | **1.20** | **2.60** |
| | | 9/12/2018 | -- | **0.0023** | **0.69** | -- | -- | <0.0040 | <0.00086 | <0.0010 | **0.019** | <0.0010 | <0.0010 | -- | -- | **1.20** | **2.78** |
| | B-123 | 11/6/2016 | <0.0010 | **0.0024** | **0.239** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0276** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **0.52** | **0.97** |
| | | 12/12/2016 | <0.0010 | **0.0011** | **0.206** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0274** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **0.57** | **0.71** |
| | | 1/8/2017 | <0.0030 | **0.0014** | **0.21** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.033** | **0.0030** | <0.0010 | <0.0010 | <0.00020 | **0.446** | **0.641** |
| | | 1/24/2017 | <0.0030 | **0.0017** | **0.20** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.032** | **0.0035** | <0.0010 | <0.0010 | **0.00087** | **0.523** | **1.06** |
| | | 2/23/2017 | <0.0030 | **0.0023** | **0.22** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | **0.0036** | <0.0010 | <0.0010 | <0.00020 | **0.540** | **1.37** |
| | | 4/25/2017 | <0.0030 | **0.0025** | **0.24** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.0036** | <0.0010 | <0.0010 | <0.00020 | **0.532** | **0.83** |
| | | 5/16/2017 | <0.0030 | **0.0020** | **0.21** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.0036** | <0.0010 | <0.0010 | <0.00020 | **0.302** | **1.35** |
| | | 6/21/2017 | <0.0030 | **0.0017** | **0.19** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.0036** | <0.0010 | <0.0010 | <0.00020 | **0.429** | **0.668** |
| | | 8/28/2017 | <0.0030 | **0.0020** | **0.20** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.0034** | <0.0010 | <0.0010 | <0.00020 | **0.574** | **1.93** |
| | | 5/30/2018 | <0.0030 | **0.0022** | **0.21** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.026** | **0.0044** | <0.0010 | <0.0010 | <0.00020 | **0.537** | **1.80** |
| | | 9/11/2018 | -- | **0.0040** | **0.27** | -- | -- | <0.0040 | <0.00086 | <0.0010 | **0.019** | **0.0040** | <0.0010 | -- | -- | **0.521** | **1.57** |
| | B-126 | 11/6/2016 | <0.0010 | **0.0099** | **0.400** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0159** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **0.39** | **0.70** |
| | | 12/12/2016 | <0.0010 | **0.0076** | **0.447** | <0.0010 | <0.0010 | **0.0013** | <0.0050 | <0.0010 | **0.0244** | <0.0100 | <0.0010 | <0.0010 | <0.00020 | **0.39** | **1.11** |
| | | 1/8/2017 | <0.0030 | **0.0063** | **0.250** | <0.0010 | <0.0010 | <0.0040 | **0.0020** | **0.0011** | **0.016** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.376** | **0.342** |
| | | 1/24/2017 | <0.0030 | **0.0050** | **0.23** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.013** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.457** | **0** |
| | | 2/23/2017 | <0.0030 | **0.0067** | **0.28** | <0.0010 | <0.0010 | <0.0040 | **0.0021** | <0.0010 | **0.015** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.525** | **1.16** |
| | | 4/25/2017 | <0.0030 | **0.0084** | **0.21** | <0.0010 | <0.0010 | **0.0047** | **0.0026** | **0.0020** | **0.013** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.388** | **1.27** |
| | | 5/16/2017 | <0.0030 | **0.0085** | **0.13** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | <0.010 | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.258** | **1.83** |
| | | 6/21/2017 | <0.0030 | **0.0094** | **0.16** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | <0.010 | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.398** | **0.51** |
| | | 8/28/2017 | <0.0030 | **0.0097** | **0.21** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.010** | <0.0010 | <0.0010 | <0.0010 | <0.00020 | **0.493** | **2.01** |
| | | 5/30/2018 | <0.0030 | **0.0086** | **0.24** | <0.0010 | <0.0010 | **0.0094** | **0.0030** | **0.0043** | **0.013** | **0.0014** | **0.0012** | <0.0010 | <0.00020 | **0.383** | **2.20** |
| | | 9/11/2018 | -- | **0.0052** | **0.31** | -- | -- | <0.0040 | **0.0019** | <0.0010 | **0.011** | <0.0010 | <0.0010 | -- | -- | **0.284** | **1.13** |

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**SUMMARY OF ANALYTICAL RESULTS**
Corrective Measures Assessment
AECI New Madrid Power Plant
New Madrid, Missouri

| Location | | Sample Date | USEPA Appendix IV Constituents | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Antimony, Total mg/l | Arsenic, Total mg/l | Barium, Total mg/l | Beryllium, Total mg/l | Cadmium, Total mg/l | Chromium, Total mg/l | Cobalt, Total mg/l | Lead, Total mg/l | Lithium, Total mg/l | Molybdenum, Total mg/l | Selenium, Total mg/l | Thallium, Total mg/l | Mercury, Total mg/l | Fluoride, Total mg/l | Radium-226 & 228 Combined pCi/L |
| | | Site GWPS | 0.006 | 0.010 | 2.0 | 0.004 | 0.005 | 0.100 | 0.006 | 0.015 | 0.040 | 0.100 | 0.050 | 0.002 | 0.002 | 4.0 | 5 |
| Down Gradient | MW-6 | 11/3/2016 | <0.0010 | <0.0010 | 0.131 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | 0.0168 | <0.0100 | <0.0010 | <0.0010 | <0.00020 | 0.36 | 0.77 |
| | | 11/3/2016 | <0.0010 | <0.0010 | 0.134 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | 0.0173 | <0.0100 | <0.0010 | <0.0010 | <0.00020 | 0.36 | 0.74 |
| | | 12/6/2016 | <0.0010 | 0.0022 | 0.137 | <0.0010 | <0.0010 | 0.0022 | <0.0050 | <0.0010 | 0.0181 | 0.0417 | <0.0010 | <0.0010 | <0.00020 | 0.32 | 1.56 |
| | | 1/4/2017 | <0.0030 | 0.0012 | 0.14 | <0.0010 | <0.0010 | <0.0040 | 0.0036 | <0.0010 | 0.023 | 0.046 | <0.0010 | <0.0010 | <0.00020 | 0.536 | 1.26 |
| | | 1/26/2017 | <0.0030 | 0.0019 | 0.16 | <0.0010 | <0.0010 | <0.0040 | 0.0033 | <0.0010 | 0.021 | 0.071 | <0.0010 | <0.0010 | <0.00020 | 0.564 | 1.92 |
| | | 2/21/2017 | <0.0030 | 0.0010 | 0.16 | <0.0010 | <0.0010 | <0.0040 | 0.0047 | <0.0010 | 0.021 | 0.034 | <0.0010 | <0.0010 | <0.00020 | 0.308 | 1.07 |
| | | 3/28/2017 | <0.0030 | <0.0010 | 0.17 | <0.0010 | <0.0010 | <0.0040 | 0.0046 | <0.0010 | 0.022 | 0.033 | <0.0010 | <0.0010 | <0.00020 | 0.519 | 1.09 |
| | | 4/27/2017 | <0.0030 | 0.0016 | 0.18 | <0.0010 | <0.0010 | <0.0040 | 0.0041 | <0.0010 | 0.019 | 0.085 | <0.0010 | <0.0010 | <0.00020 | 0.328 | 1.33 |
| | | 4/27/2017 | <0.0030 | 0.0014 | 0.17 | <0.0010 | <0.0010 | <0.0040 | 0.0040 | <0.0010 | 0.018 | 0.080 | <0.0010 | <0.0010 | <0.00020 | 0.314 | 1.34 |
| | | 5/18/2017 | <0.0030 | <0.0010 | 0.18 | <0.0010 | <0.0010 | <0.0040 | 0.0050 | <0.0010 | 0.023 | 0.048 | <0.0010 | <0.0010 | <0.00020 | <0.250 | 1.05 |
| | | 6/20/2017 | <0.0030 | 0.0012 | 0.16 | <0.0010 | <0.0010 | <0.0040 | 0.0054 | <0.0010 | 0.022 | 0.021 | 0.0010 | <0.0010 | <0.00020 | 0.362 | 2.39 |
| | | 8/16/2017 | <0.0030 | <0.0010 | 0.15 | <0.0010 | <0.0010 | <0.0040 | 0.0060 | <0.0010 | 0.024 | 0.010 | <0.0010 | <0.0010 | <0.00020 | 0.316 | 1.65 |
| | | 5/30/2018 | <0.0030 | <0.0010 | 0.16 | <0.0010 | <0.0010 | <0.0040 | 0.0052 | <0.0010 | 0.018 | 0.063 | <0.0010 | <0.0010 | <0.00020 | 0.349 | 0.68 |
| | | 9/11/2018 | -- | <0.0010 | 0.11 | -- | -- | <0.0040 | 0.0028 | <0.0010 | <0.010 | 0.042 | <0.0010 | -- | -- | 0.319 | 0.790 |
| | MW-7 | 11/3/2016 | <0.0010 | 0.0021 | 0.181 | <0.0010 | <0.0010 | <0.0010 | 0.0062 | <0.0010 | 0.0223 | 3.20 | <0.0010 | <0.0010 | <0.00020 | 0.34 | 1.13 |
| | | 12/6/2016 | <0.0010 | 0.0032 | 0.150 | <0.0010 | 0.0011 | <0.0010 | 0.0098 | <0.0010 | 0.0227 | 3.24 | <0.0010 | <0.0010 | <0.00020 | 0.33 | 1.10 |
| | | 1/4/2017 | <0.0030 | 0.0045 | 0.11 | <0.0010 | 0.0012 | <0.0040 | 0.0067 | <0.0010 | 0.031 | 2.8 | <0.0010 | <0.0010 | <0.00020 | 0.464 | 1.28 |
| | | 1/26/2017 | <0.0030 | 0.0036 | 0.12 | <0.0010 | 0.0016 | <0.0040 | 0.0059 | <0.0010 | 0.027 | 2.9 | <0.0010 | <0.0010 | <0.00020 | 0.564 | 0.78 |
| | | 2/22/2017 | <0.0030 | 0.0021 | 0.15 | <0.0010 | <0.0010 | <0.0040 | 0.0068 | <0.0010 | 0.030 | 3.4 | <0.0010 | <0.0010 | <0.00020 | 0.287 | 3.80 |
| | | 3/30/2017 | <0.0030 | 0.0018 | 0.15 | <0.0010 | <0.0010 | <0.0040 | 0.0067 | <0.0010 | 0.028 | 3.4 | <0.0010 | <0.0010 | <0.00020 | 0.496 | 1.40 |
| | | 4/26/2017 | <0.0030 | 0.0034 | 0.14 | <0.0010 | 0.0014 | <0.0040 | 0.0051 | <0.0010 | 0.027 | 3.9 | <0.0010 | <0.0010 | <0.00020 | 0.277 | 1.73 |
| | | 5/18/2017 | <0.0030 | 0.0037 | 0.14 | <0.0010 | <0.0010 | <0.0040 | 0.0030 | <0.0010 | 0.034 | 3.9 | <0.0010 | <0.0010 | <0.00020 | <0.250 | 2.72 |
| | | 6/20/2017 | <0.0030 | 0.0028 | 0.15 | <0.0010 | 0.0016 | <0.0040 | 0.0070 | 0.0018 | 0.028 | 3.5 | 0.0021 | 0.0020 | <0.00020 | 0.388 | 1.71 |
| | | 8/16/2017 | <0.0030 | 0.0020 | 0.17 | <0.0010 | <0.0010 | <0.0040 | 0.0073 | <0.0010 | 0.031 | 3.6 | <0.0010 | <0.0010 | <0.00020 | 0.410 | 1.54 |
| | | 5/30/2018 | <0.0030 | 0.0023 | 0.13 | <0.0010 | <0.0010 | <0.0040 | 0.0058 | <0.0010 | 0.019 | 3.4 | <0.0010 | <0.0010 | <0.00020 | 0.431 | 0.63 |
| | | 9/11/2018 | -- | 0.0024 | 0.14 | -- | -- | <0.0040 | 0.0076 | <0.0010 | 0.014 | 3.0 | <0.0010 | -- | -- | 0.330 | 1.36 |
| | MW-8 | 11/4/2016 | <0.0010 | 0.0040 | 0.115 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | 0.0197 | 0.737 | <0.0010 | <0.0010 | <0.00020 | 0.29 | 1.36 |
| | | 12/7/2016 | <0.0010 | 0.0026 | 0.111 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | 0.0223 | 0.706 | <0.0010 | <0.0010 | <0.00020 | 0.29 | 1.46 |
| | | 1/5/2017 | <0.0030 | 0.0046 | 0.066 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.023 | 0.96 | <0.0010 | <0.0010 | <0.00020 | 0.366 | 0.56 |
| | | 1/5/2017 | <0.0030 | 0.0049 | 0.068 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.023 | 0.96 | <0.0010 | <0.0010 | <0.00020 | 0.367 | 2.82 |
| | | 1/26/2017 | <0.0030 | 0.0045 | 0.085 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.022 | 0.87 | <0.0010 | <0.0010 | <0.00020 | 0.538 | 0.822 |
| | | 2/21/2017 | <0.0030 | 0.0057 | 0.10 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.025 | 0.83 | <0.0010 | <0.0010 | <0.00020 | 0.288 | 2.29 |
| | | 3/30/2017 | <0.0030 | 0.0054 | 0.11 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.025 | 0.83 | <0.0010 | <0.0010 | <0.00020 | 0.475 | 1.35 |
| | | 4/26/2017 | <0.0030 | 0.0050 | 0.082 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.018 | 1.0 | <0.0010 | <0.0010 | <0.00020 | 0.300 | 1.01 |
| | | 5/17/2017 | <0.0030 | 0.0062 | 0.098 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.022 | 1.2 | <0.0010 | <0.0010 | <0.00020 | 0.348 | 1.43 |
| | | 6/21/2017 | <0.0030 | 0.0060 | 0.10 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.022 | 0.93 | <0.0010 | <0.0010 | <0.00020 | 0.361 | 1.42 |
| | | 8/16/2017 | <0.0030 | 0.0048 | 0.10 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.025 | 1.0 | <0.0010 | <0.0010 | <0.00020 | 0.376 | 0.91 |
| | | 5/30/2018 | <0.0030 | 0.0053 | 0.082 | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | 0.017 | 0.93 | <0.0010 | <0.0010 | <0.00020 | 0.343 | 1.07 |
| | | 9/12/2018 | -- | 0.0045 | 0.082 | -- | -- | <0.0040 | 0.0016 | <0.0010 | 0.012 | 0.86 | <0.0010 | -- | -- | 0.290 | 0.840 |

**TABLE I**
**SUMMARY OF ANALYTICAL RESULTS**
Corrective Measures Assessment
AECI New Madrid Power Plant
New Madrid, Missouri

| Location | | Sample Date | Antimony, Total mg/l | Arsenic, Total mg/l | Barium, Total mg/l | Beryllium, Total mg/l | Cadmium, Total mg/l | Chromium, Total mg/l | Cobalt, Total mg/l | Lead, Total mg/l | Lithium, Total mg/l | Molybdenum, Total mg/l | Selenium, Total mg/l | Thallium, Total mg/l | Mercury, Total mg/l | Fluoride, Total mg/l | Radium-226 & 228 Combined pCi/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | USEPA Appendix IV Constituents | | | | | | | | | | | | | | |
| | | *Site GWPS* | *0.006* | *0.010* | *2.0* | *0.004* | *0.005* | *0.100* | *0.006* | *0.015* | *0.040* | *0.100* | *0.050* | *0.002* | *0.002* | *4.0* | *5* |
| Down Gradient | MW-9 | 11/4/2016 | <0.0010 | <0.0010 | **0.0984** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0258** | **0.312** | <0.0010 | <0.0010 | <0.00020 | **0.53** | **3.12** |
| | | 12/7/2016 | <0.0010 | <0.0010 | **0.0842** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0296** | **0.337** | **0.0015** | <0.0010 | <0.00020 | **0.49** | **1.40** |
| | | 1/5/2017 | <0.0030 | <0.0010 | **0.075** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.034** | **0.32** | <0.0010 | <0.0010 | <0.00020 | **0.508** | **1.56** |
| | | 1/27/2017 | <0.0030 | <0.0010 | **0.072** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.35** | <0.0010 | <0.0010 | <0.00020 | **0.557** | **0.53** |
| | | 2/21/2017 | <0.0030 | <0.0010 | **0.089** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | **0.33** | <0.0010 | <0.0010 | <0.00020 | **0.481** | **1.47** |
| | | 3/30/2017 | <0.0030 | <0.0010 | **0.080** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.33** | <0.0010 | <0.0010 | <0.00020 | **0.654** | **1.42** |
| | | 4/26/2017 | <0.0030 | <0.0010 | **0.069** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.025** | **0.42** | <0.0010 | <0.0010 | <0.00020 | **0.481** | **0.65** |
| | | 5/17/2017 | <0.0030 | <0.0010 | **0.098** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.034** | **0.44** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.30** |
| | | 6/20/2017 | <0.0030 | <0.0010 | **0.092** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.36** | <0.0010 | <0.0010 | <0.00020 | **0.507** | **0.71** |
| | | 6/20/2017 | <0.0030 | <0.0010 | **0.092** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.35** | <0.0010 | <0.0010 | <0.00020 | **0.528** | **0.46** |
| | | 8/16/2017 | <0.0030 | <0.0010 | **0.097** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.035** | **0.35** | <0.0010 | <0.0010 | <0.00020 | **0.561** | **0.98** |
| | | 5/30/2018 | <0.0030 | <0.0010 | **0.089** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.026** | **0.34** | <0.0010 | <0.0010 | <0.00020 | **0.496** | **0.599** |
| | | 9/12/2018 | -- | <0.0010 | **0.074** | -- | -- | <0.0040 | <0.00086 | <0.0010 | **0.021** | **0.34** | <0.0010 | -- | -- | **0.440** | **0.216** |
| | P-1 | 11/5/2016 | <0.0010 | <0.0010 | **0.0533** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0221** | **0.0194** | **0.0014** | <0.0010 | <0.00020 | **0.38** | **1.48** |
| | | 12/8/2016 | <0.0010 | <0.0010 | **0.0552** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0248** | **0.0506** | <0.0010 | <0.0010 | <0.00020 | **0.44** | **NS** |
| | | 12/8/2016 | <0.0010 | <0.0010 | **0.0534** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0240** | **0.0378** | <0.0010 | <0.0010 | <0.00020 | **0.43** | **NS** |
| | | 1/6/2017 | <0.0030 | <0.0010 | **0.051** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.028** | **0.034** | <0.0010 | <0.0010 | <0.00020 | **0.552** | **1.29** |
| | | 1/28/2017 | <0.0030 | <0.0010 | **0.053** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.024** | **0.0062** | <0.0010 | <0.00020 | **0.516** | **0.75** |
| | | 2/21/2017 | <0.0030 | <0.0010 | **0.065** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.013** | **0.0051** | <0.0010 | <0.00020 | **0.364** | **1.28** |
| | | 3/30/2017 | <0.0030 | <0.0010 | **0.070** | <0.0010 | <0.0010 | **0.018** | <0.0020 | <0.0010 | **0.030** | **0.011** | **0.0038** | <0.0010 | <0.00020 | **0.519** | **1.54** |
| | | 4/26/2017 | **0.0031** | <0.0010 | **0.063** | <0.0010 | <0.0010 | **0.0051** | <0.0020 | <0.0010 | **0.026** | **0.013** | **0.0037** | <0.0010 | <0.00020 | **0.378** | **0.78** |
| | | 5/17/2017 | <0.0030 | <0.0010 | **0.068** | <0.0010 | <0.0010 | **0.0071** | <0.0020 | <0.0010 | **0.031** | **0.015** | **0.0052** | <0.0010 | <0.00020 | <0.250 | **1.98** |
| | | 6/21/2017 | <0.0030 | <0.0010 | **0.062** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.027** | **0.011** | **0.0054** | <0.0010 | <0.00020 | **0.411** | **1.34** |
| | | 8/16/2017 | <0.0030 | <0.0010 | **0.055** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.011** | **0.0033** | <0.0010 | <0.00020 | **0.416** | **0.63** |
| | | 5/29/2018 | <0.0030 | <0.0010 | **0.063** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.013** | **0.0054** | <0.0010 | <0.00020 | **0.420** | **0.76** |
| | | 9/12/2018 | -- | <0.0010 | **0.059** | -- | -- | **0.0071** | <0.00086 | <0.0010 | **0.020** | **0.023** | **0.0044** | -- | -- | **0.340** | **0.663** |
| | P-2 | 11/4/2016 | <0.0010 | <0.0010 | **0.0963** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0188** | **0.279** | **0.0014** | <0.0010 | <0.00020 | **0.52** | **0.00** |
| | | 12/7/2016 | <0.0010 | <0.0010 | **0.0888** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0174** | **0.351** | **0.0010** | <0.0010 | <0.00020 | **0.61** | **2.05** |
| | | 1/5/2017 | <0.0030 | <0.0010 | **0.076** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.020** | **0.35** | <0.0010 | <0.0010 | <0.00020 | **0.643** | **0.74** |
| | | 1/28/2017 | <0.0030 | <0.0010 | **0.075** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.016** | **0.34** | **0.0011** | <0.0010 | <0.00020 | **0.662** | **0.73** |
| | | 1/28/2017 | <0.0030 | <0.0010 | **0.077** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.022** | **0.35** | <0.0010 | <0.0010 | <0.00020 | **0.767** | **0.83** |
| | | 2/21/2017 | <0.0030 | <0.0010 | **0.098** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.29** | **0.0012** | <0.0010 | <0.00020 | **0.512** | **1.15** |
| | | 3/30/2017 | <0.0030 | <0.0010 | **0.094** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.023** | **0.29** | **0.0011** | <0.0010 | <0.00020 | **0.679** | **1.33** |
| | | 4/26/2017 | <0.0030 | <0.0010 | **0.084** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.018** | **0.31** | <0.0010 | <0.0010 | <0.00020 | **0.566** | **1.01** |
| | | 5/17/2017 | <0.0030 | <0.0020 | **0.082** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.022** | **0.32** | <0.0020 | <0.0010 | <0.00020 | **0.306** | **0.45** |
| | | 6/20/2017 | <0.0030 | **0.0010** | **0.086** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.022** | **0.27** | **0.0022** | <0.0010 | <0.00020 | **0.534** | **1.47** |
| | | 8/17/2016 | <0.0030 | <0.0010 | **0.100** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.028** | **0.27** | **0.0014** | <0.0010 | <0.00020 | **0.520** | **0.52** |
| | | 6/1/2018 | <0.0030 | <0.0010 | **0.096** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.020** | **0.32** | **0.0015** | <0.0010 | <0.00020 | **0.544** | **1.04** |
| | | 5/29/2018 | <0.0030 | <0.0010 | **0.095** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.019** | **0.32** | **0.0014** | <0.0010 | <0.00020 | **0.542** | **0.395** |
| | | 9/12/2018 | -- | <0.0010 | **0.067** | -- | -- | <0.0040 | <0.00086 | <0.0010 | <0.010 | **0.32** | <0.0010 | -- | -- | **0.561** | **0.428** |

**TABLE I**
**SUMMARY OF ANALYTICAL RESULTS**
Corrective Measures Assessment
AECI New Madrid Power Plant
New Madrid, Missouri

| Location | | Sample Date | Antimony, Total mg/l | Arsenic, Total mg/l | Barium, Total mg/l | Beryllium, Total mg/l | Cadmium, Total mg/l | Chromium, Total mg/l | Cobalt, Total mg/l | Lead, Total mg/l | Lithium, Total mg/l | Molybdenum, Total mg/l | Selenium, Total mg/l | Thallium, Total mg/l | Mercury, Total mg/l | Fluoride, Total mg/l | Radium-226 & 228 Combined pCi/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | USEPA Appendix IV Constituents | | | | | | | | | | | | | | |
| | | *Site GWPS* | *0.006* | *0.010* | *2.0* | *0.004* | *0.005* | *0.100* | *0.006* | *0.015* | *0.040* | *0.100* | *0.050* | *0.002* | *0.002* | *4.0* | *5* |
| Down Gradient | P-3 | 11/4/2016 | <0.0010 | <0.0010 | **0.102** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0250** | **1.28** | **0.0041** | <0.0010 | <0.00020 | **0.36** | **0.29** |
| Down Gradient | P-3 | 12/7/2016 | <0.0010 | <0.0010 | **0.111** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0285** | **1.56** | **0.0080** | <0.0010 | <0.00020 | **0.48** | **1.03** |
| Down Gradient | P-3 | 1/5/2017 | <0.0030 | <0.0010 | **0.098** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.033** | **1.4** | **0.0046** | <0.0010 | <0.00020 | **0.481** | **0.72** |
| Down Gradient | P-3 | 1/28/2017 | <0.0030 | <0.0010 | **0.10** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.027** | **1.3** | **0.0029** | <0.0010 | <0.00020 | **0.463** | **0.77** |
| Down Gradient | P-3 | 2/21/2017 | <0.0030 | <0.0010 | **0.10** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **1.2** | **0.0042** | <0.0010 | <0.00020 | **0.381** | **1.40** |
| Down Gradient | P-3 | 3/30/2017 | <0.0030 | <0.0010 | **0.10** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | **0.0047** | **0.030** | **1.1** | **0.0048** | <0.0010 | <0.00020 | **0.591** | **0.30** |
| Down Gradient | P-3 | 3/30/2017 | <0.0030 | <0.0010 | **0.10** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **1.1** | **0.0045** | <0.0010 | <0.00020 | **0.588** | **0.77** |
| Down Gradient | P-3 | 4/26/2017 | <0.0030 | <0.0010 | **0.10** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.027** | **1.4** | **0.0036** | <0.0010 | <0.00020 | **0.463** | **0.49** |
| Down Gradient | P-3 | 5/17/2017 | <0.0030 | <0.0010 | **0.093** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.032** | **1.1** | **0.0037** | <0.0010 | <0.00020 | <0.250 | **0.86** |
| Down Gradient | P-3 | 6/20/2017 | <0.0030 | <0.0010 | **0.095** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **1.0** | **0.0060** | <0.0010 | <0.00020 | **0.461** | **1.65** |
| Down Gradient | P-3 | 8/16/2017 | <0.0030 | <0.0010 | **0.098** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | **1.3** | **0.0046** | <0.0010 | <0.00020 | **0.482** | **1.00** |
| Down Gradient | P-3 | 5/29/2018 | <0.0030 | <0.0010 | **0.095** | <0.0010 | <0.0010 | **0.0048** | <0.0020 | **0.0016** | **0.023** | **1.3** | **0.0054** | <0.0010 | <0.00020 | **0.560** | **0.604** |
| Down Gradient | P-3 | 9/12/2018 | -- | <0.0010 | **0.086** | -- | -- | <0.0040 | <0.00086 | <0.0010 | **0.018** | **1.4** | **0.0057** | -- | -- | **0.426** | **0.125** |
| Down Gradient | P-4 | 11/4/2016 | <0.0010 | <0.0010 | **0.144** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0379** | **0.0320** | **0.0022** | <0.0010 | <0.00020 | **0.34** | **0.53** |
| Down Gradient | P-4 | 12/7/2016 | <0.0010 | <0.0010 | **0.109** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0251** | **0.0318** | **0.0010** | <0.0010 | <0.00020 | **0.48** | **1.45** |
| Down Gradient | P-4 | 1/5/2017 | <0.0030 | <0.0010 | **0.12** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.031** | **0.033** | **0.0018** | <0.0010 | <0.00020 | **0.568** | **0.89** |
| Down Gradient | P-4 | 1/28/2017 | <0.0030 | <0.0010 | **0.11** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.029** | **0.031** | <0.0010 | <0.0010 | <0.00020 | **0.469** | **0.48** |
| Down Gradient | P-4 | 2/21/2017 | <0.0030 | <0.0010 | **0.13** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.043** | **0.029** | **0.0014** | <0.0010 | <0.00020 | **0.362** | **0.45** |
| Down Gradient | P-4 | 3/30/2017 | <0.0030 | <0.0010 | **0.13** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.041** | **0.029** | **0.0019** | <0.0010 | <0.00020 | **0.543** | **0.11** |
| Down Gradient | P-4 | 4/26/2017 | <0.0030 | <0.0010 | **0.12** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.032** | **0.030** | <0.0010 | <0.0010 | <0.00020 | **0.381** | **0.76** |
| Down Gradient | P-4 | 5/17/2017 | <0.0030 | <0.0010 | **0.11** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.038** | **0.027** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **0.98** |
| Down Gradient | P-4 | 5/17/2017 | <0.0030 | <0.0020 | **0.12** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.038** | **0.029** | <0.0020 | <0.0010 | <0.00020 | <0.250 | **1.60** |
| Down Gradient | P-4 | 6/20/2017 | <0.0030 | <0.0010 | **0.12** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.043** | **0.026** | **0.0019** | <0.0010 | <0.00020 | **0.380** | **1.09** |
| Down Gradient | P-4 | 8/16/2017 | <0.0030 | <0.0010 | **0.14** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.050** | **0.030** | **0.0024** | <0.0010 | <0.00020 | <0.250 | **0.86** |
| Down Gradient | P-4 | 5/29/2018 | <0.0030 | <0.0010 | **0.11** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.033** | **0.0030** | <0.0010 | <0.00020 | **0.357** | **0.594** |
| Down Gradient | P-4 | 9/12/2018 | -- | <0.0010 | **0.11** | -- | -- | <0.0040 | <0.00086 | <0.0010 | **0.028** | **0.025** | **0.0022** | -- | -- | **0.369** | **0.297** |

**TABLE I**
**SUMMARY OF ANALYTICAL RESULTS**
Corrective Measures Assessment
AECI New Madrid Power Plant
New Madrid, Missouri

| Location | | Sample Date | USEPA Appendix IV Constituents | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Antimony, Total mg/l | Arsenic, Total mg/l | Barium, Total mg/l | Beryllium, Total mg/l | Cadmium, Total mg/l | Chromium, Total mg/l | Cobalt, Total mg/l | Lead, Total mg/l | Lithium, Total mg/l | Molybdenum, Total mg/l | Selenium, Total mg/l | Thallium, Total mg/l | Mercury, Total mg/l | Fluoride, Total mg/l | Radium-226 & 228 Combined pCi/L |
| | | *Site GWPS* | *0.006* | *0.010* | *2.0* | *0.004* | *0.005* | *0.100* | *0.006* | *0.015* | *0.040* | *0.100* | *0.050* | *0.002* | *0.002* | *4.0* | *5* |
| Down Gradient | P-5 | 11/3/2016 | <0.0010 | **0.0053** | **0.125** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0179** | **0.235** | <0.0010 | <0.0010 | <0.00020 | **0.18** | **2.00** |
| | | 12/6/2016 | <0.0010 | **0.0081** | **0.110** | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | **0.0169** | **0.235** | <0.0010 | <0.0010 | <0.00020 | **0.20** | **1.42** |
| | | 1/4/2017 | <0.0030 | **0.0056** | **0.13** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.025** | **0.25** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.65** |
| | | 1/26/2017 | <0.0030 | **0.0068** | **0.14** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.23** | <0.0010 | <0.0010 | <0.00020 | **0.364** | **0.28** |
| | | 2/22/2017 | <0.0030 | **0.011** | **0.15** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.27** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.23** |
| | | 3/30/2017 | <0.0030 | **0.0089** | **0.15** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.25** | <0.0010 | <0.0010 | <0.00020 | **0.438** | **2.06** |
| | | 4/26/2017 | <0.0030 | **0.0099** | **0.17** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.022** | **0.30** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.99** |
| | | 5/18/2017 | <0.0030 | **0.0069** | **0.18** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.030** | **0.36** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.30** |
| | | 6/20/2017 | <0.0030 | **0.0083** | **0.16** | <0.0010 | <0.0010 | <0.0040 | **0.0020** | <0.0010 | **0.026** | **0.26** | **0.0015** | <0.0010 | <0.00020 | **0.272** | **2.16** |
| | | 8/16/2017 | <0.0030 | **0.0064** | **0.13** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.024** | **0.23** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.22** |
| | | 5/29/2018 | <0.0030 | **0.0066** | **0.17** | <0.0010 | <0.0010 | <0.0040 | <0.0020 | <0.0010 | **0.022** | **0.28** | <0.0010 | <0.0010 | <0.00020 | <0.250 | **1.23** |
| | | 9/11/2018 | -- | **0.0066** | **0.12** | -- | -- | <0.0040 | **0.0012** | <0.0010 | **0.012** | **0.26** | <0.0010 | -- | -- | <0.250 | **2.40** |

Notes:
Bold value: Detection above laboratory reporting limit
[yellow highlight] Statistically significant level concentration
GWPS: Groundwater Protection Standards
mg/L: milligram per liter
"-- " Constituent not analyzed
NS: No Sample, sample was lost in transit.
pCi/L: picoCurie per liter

**TABLE II**

**SUMMARY OF CORRECTIVE MEASURES**

CORRECTIVE MEASURES ASSESSMENT

AECI - NEW MADRID POWER PLANT- POND 003

NEW MADRID, MISSOURI

| Alternative Number | Remedial Alternative Description | THRESHOLD CRITERIA: Be protective of human health and the environment | THRESHOLD CRITERIA: Attain the groundwater protective standard | THRESHOLD CRITERIA: Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment | THRESHOLD CRITERIA: 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 | THRESHOLD CRITERIA: Management of waste all applicable RCRA requirements | BALANCING CRITERIA: CATEGORY 1 Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success that the Remedy will Prove Successful | Sub-Category 1: 1 *Magnitude of reduction of existing risks* | Sub-Category 1: 2 *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy* | Sub-Category 1: 3 *Type and degree of long-term management required, including monitoring, operation and maintenance* | Sub-Category 1: 4 *Short term risk to community or environment during implementation of remedy* | Sub-Category 1: 5 *Time until full protection is achieved* | Sub-Category 1: 6 *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* | Sub-Category 1: 7 *Long-term reliability of engineering and institutional controls* | Sub-Category 1: 8 *Potential need for replacement of the remedy* | CATEGORY 2 Effectiveness in Controlling the Source to Reduce Further Releases | Sub-Cat. 2: 1 *Extent to which containment practices will reduce further releases* | Sub-Cat. 2: 2 *Extent to which treatment technologies may be used* | CATEGORY 3 The Ease or Difficulty of Implementation | Sub-Category 3: 1 *Degree of difficulty associated with constructing the technology* | Sub-Category 3: 2 *Expected operational reliability of the technologies* | Sub-Category 3: 3 *Need to coordinate with and obtain necessary approvals and permits from other agencies* | Sub-Category 3: 4 *Availability of necessary equipment and specialists* | Sub-Category 3: 5 *Available capacity and location of needed treatment, storage, and disposal services* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Closure In Place (CIP) with Capping and Monitored Natural Attenuation (MNA) | ✓ | ✓ | ✓ | ✓ | ✓ | Green | Green | Yellow | Green | Green | Yellow | Green | Yellow | Yellow | Yellow | Yellow | Green | Green | Green | Green | Green | Green | Green |
| 2 | CIP with In-Situ Stabilization (ISS), Capping, and MNA | ✓ | ✓ | ✓ | ✓ | ✓ | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Red | Green | Green | Yellow | Yellow | Green | Red | Red | Green | Red | Red | Green |
| 3 | CIP with Capping and Hydraulic Containment through Groundwater Pumping | ✓ | ✓ | ✓ | ✓ | ✓ | Yellow | Green | Yellow | Red | Green | Yellow | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Green | Yellow | Yellow | Green | Yellow |
| 4 | CIP with Capping and Hydraulic Containment through Groundwater Pumping and Barrier Wall | ✓ | ✓ | ✓ | ✓ | ✓ | Yellow | Green | Yellow | Red | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Yellow | Yellow | Red | Yellow | Yellow |
| 5 | Closure by Removal with MNA | ✓ | ✓ | ✓ | ✓ | ✓ | Yellow | Red | Green | Green | Red | Yellow | Red | Green | Green | Green | Green | Green | Red | Red | Green | Red | Red | Yellow |

**COLOR LEGEND**

- Green: **Most favorable when compared to other alternatives**
- Yellow: **Less favorable when compared to other alternatives**
- Red: **Least favorable when compared to other alternatives**

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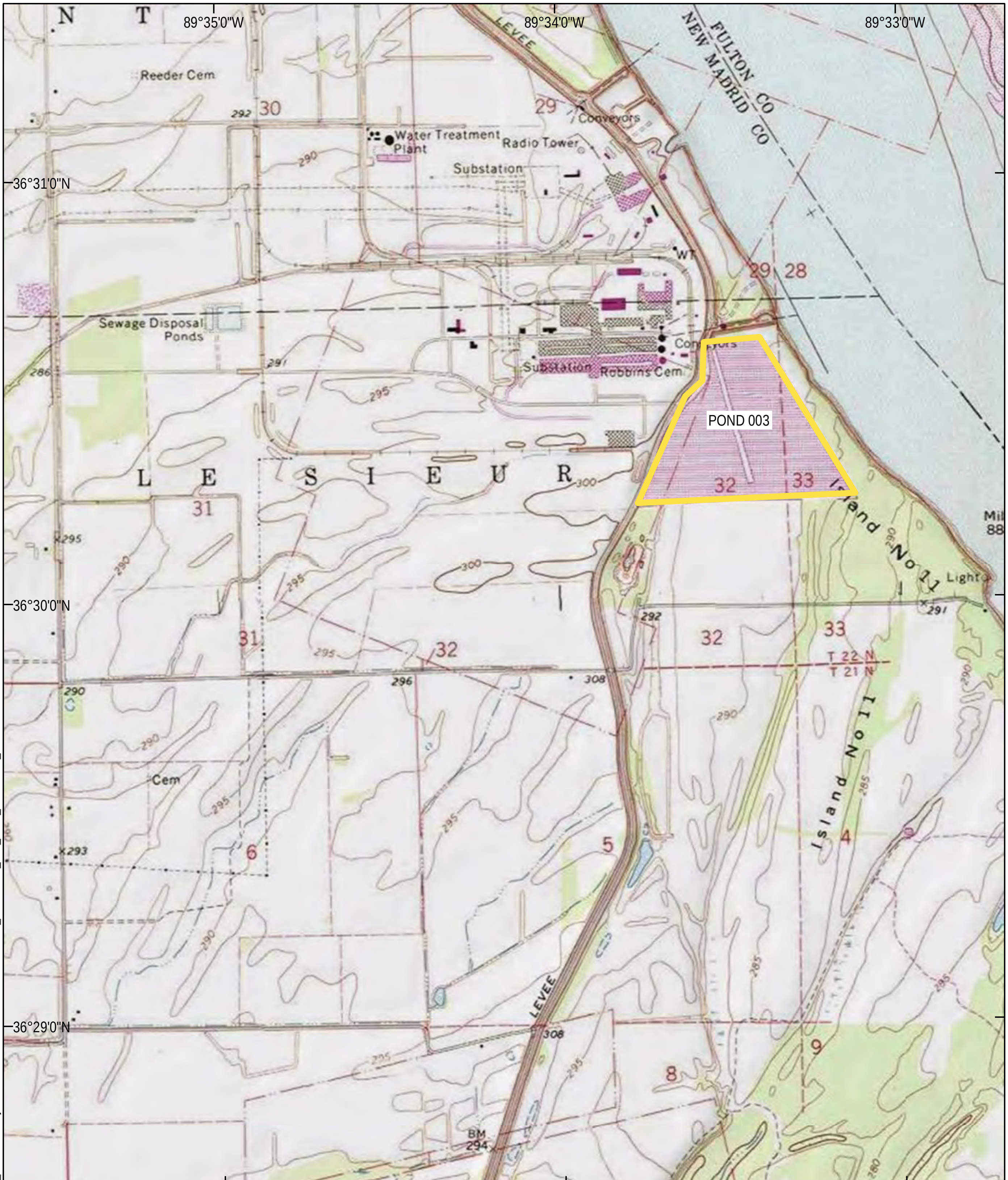
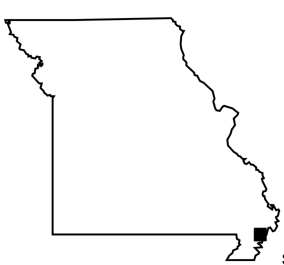
1. For context, this a relative comparison of remedial options for this site. Site conditions, weather, and site-specific considerations are made in this table. This is not a comparison to all options at all sites.

# FIGURES



MAP SOURCE: ESRI
SITE COORDINATES: 36°30'23"N, 89°33'29"W

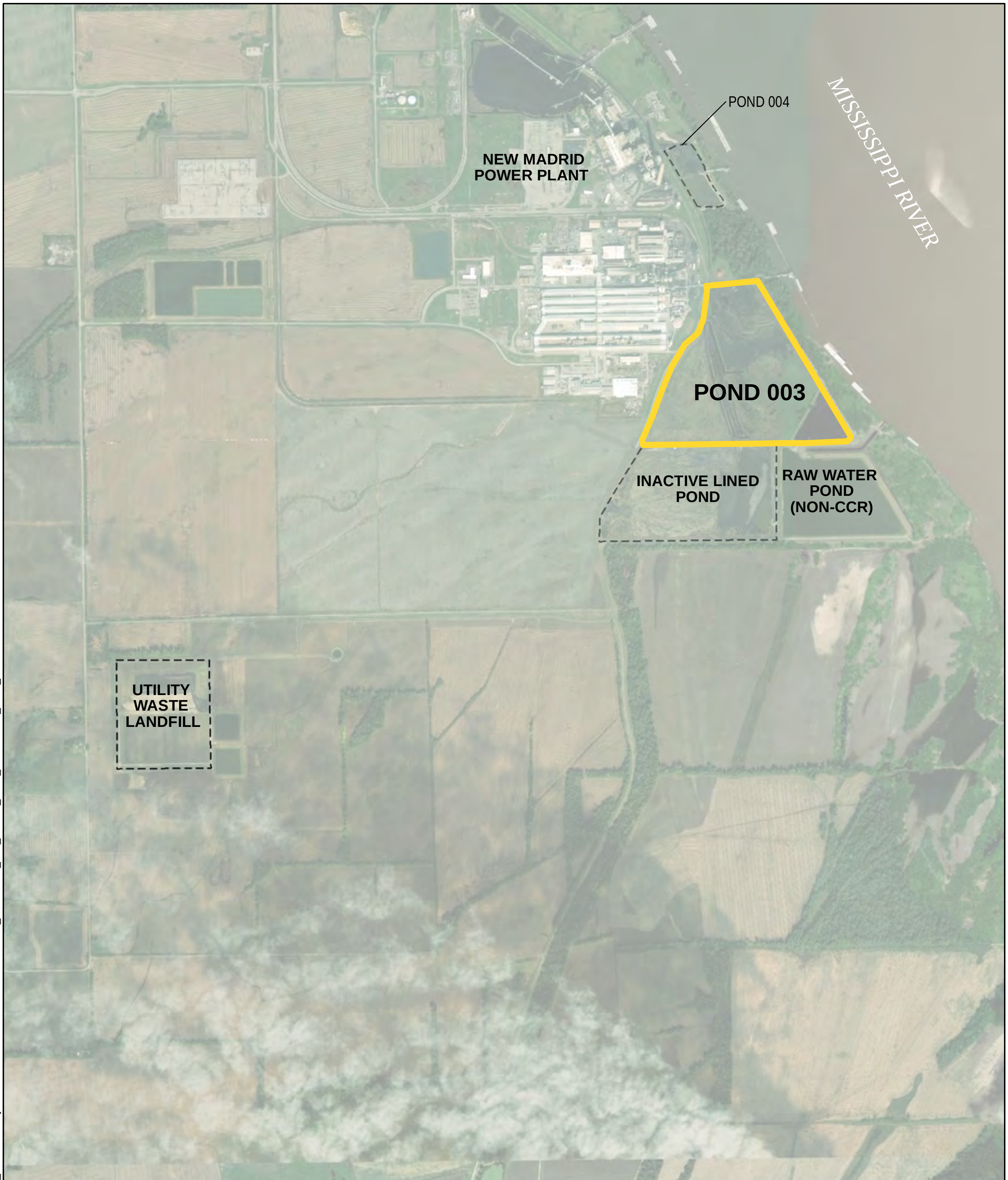
CORRECTIVE MEASURES ASSESSMENT
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT - POND 003
NEW MADRID, MISSOURI

SITE LOCATION MAP

APPROXIMATE SCALE: 1 IN = 2000 FT
SEPTEMBER 2019

FIGURE 1-1

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AECI\New Madrid\GIS\MXDs\2019_08\129342_020_0001_PROJECT_LOCUS.mxd — USER: hwachholz — LAST SAVED: 8/26/2019 11:35:20 AM




NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. AERIAL IMAGERY SOURCE: ESRI, 19 MAY 2016.

0 1,000 2,000
SCALE IN FEET

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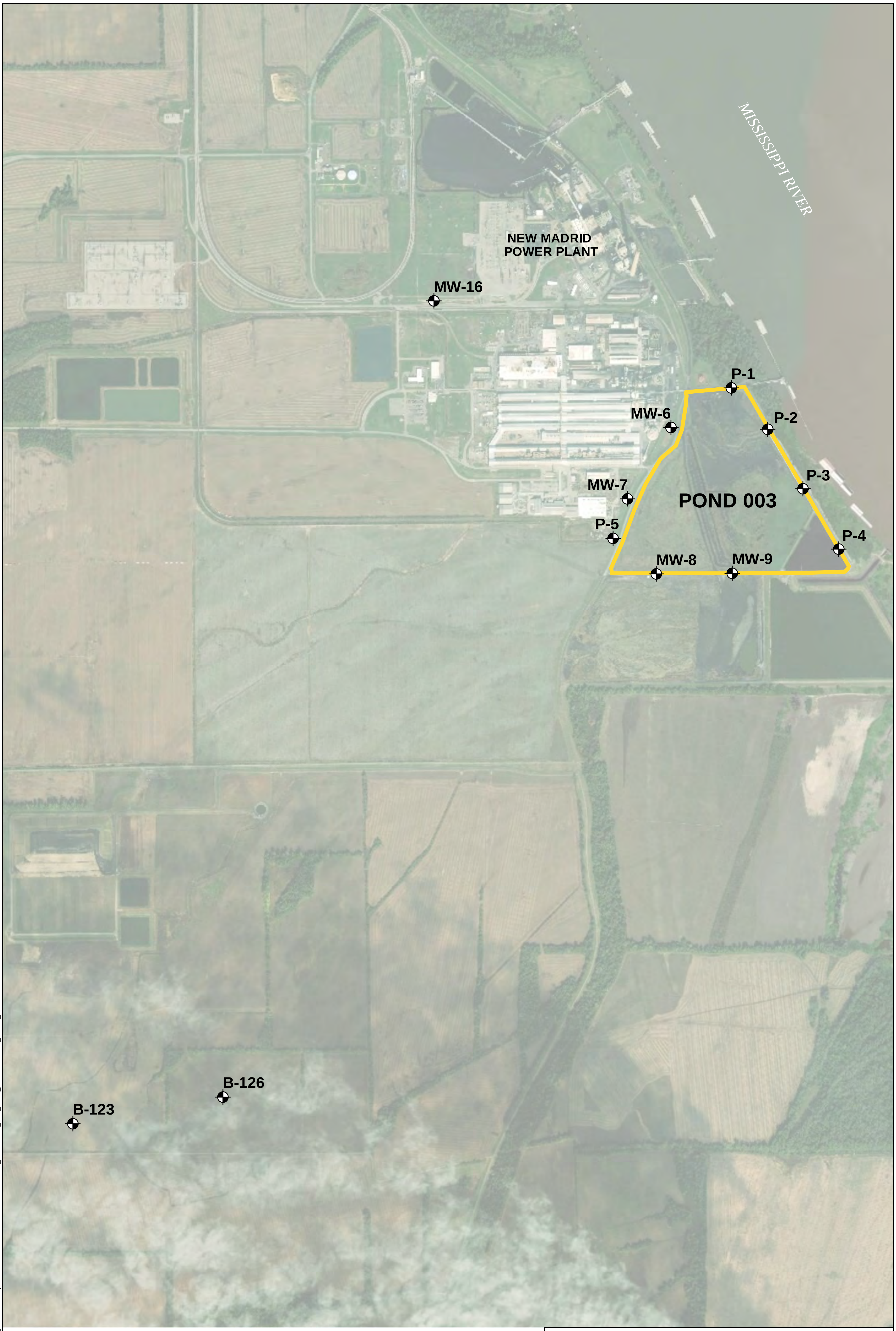
CORRECTIVE MEASURES ASSESSMENT
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT - POND 003
NEW MADRID, MISSOURI

SITE FEATURES MAP

SEPTEMBER 2019

FIGURE 1-2

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AECI\New Madrid\GIS\MXDs\2019_08\129342_020_0001-2_SITE_FEATURES_MAP_.mxd — USER: hwachholz — LAST SAVED: 9/11/2019 10:12:09 AM




GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AECI\New Madrid\GIS\MXDs\2019_08\129342_020_0001_MONITORING_WELL_LOCATION.mxd — USER: hwachholz — LAST SAVED: 9/11/2019 10:09:03 AM

**LEGEND**

MONITORING

POND 003

**NOTE**
1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI, 19 MAY 2016.

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CORRECTIVE MEASURES ASSESSMENT
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT - POND 003
NEW MADRID, MISSOURI

MONITORING WELL LOCATION MAP

SEPTEMBER 2019
SCALE: AS SHOWN

FIGURE 2-1


LEGEND

P-1 MONITORING WELL

MW-8 MONITORING WELL WITH MOLYBDENUM CONCENTRATION ABOVE THE GWPS

UNIT BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. GWPS = GROUNDWATER PROTECTION STANDARDS
3. REFER TO TABLE I FOR GROUNDWATER ANALYTICAL RESULTS.
4. AERIAL IMAGERY SOURCE: ESRI

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CORRECTIVE MEASURES ASSESSMENT
ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT - POND 003
NEW MADRID, MISSOURI

MONITORING WELL LOCATIONS WITH STATISTICALLY SIGNIFICANT LEVELS ABOVE GWPS

SEPTEMBER 2019

FIGURE 2-2

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AECI\New Madrid\GIS\MXDs\2019_08\129342_020_0002-2_WELL_LOCATION_WITH_GWPS.mxd — USER: hwachholz — LAST SAVED: 8/26/2019 11:39:45 AM

**FIGURE 4-1**

**REMEDIAL ALTERNATIVE ROADMAP**

CORRECTIVE MEASURES ASSESSMENT

ASSOCIATED ELECTRIC COOPERATIVE, INC

NEW MADRID POWER PLANT - POND 003

NEW MADRID, MISSOURI

| Alternative Number | Remedial Alternative Description | Pond 003 Closure Description | Groundwater Remedy Components | | |
|---|---|---|---|---|---|
| | | | A. Groundwater Remedy Approach | B. Groundwater Treatment Method | C. Post-Closure Actions |
| *1* | Closure In Place (CIP) with Capping and Monitored Natural Attenuation (MNA) | CIP with Low Permeability Cap | **Natural Attenuation with Monitoring**<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS through process of natural attenuation | **No Active Treatment**<br>No active treatment technologies for groundwater to address CCR constituents | **MNA**<br>Long-term groundwater monitoring to confirm reduction of CCR constituents |
| *2* | CIP with In-Situ Stabilization (ISS), Capping and MNA | CIP with ISS and Low Permeability Cap | | | |
| *3* | CIP with Capping and Hydraulic Containment through Groundwater Pumping and Ex-Situ Treatment | CIP with Low Permeability Cap | **Hydraulic Containment**<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells | **Ex-Situ Treatment**<br>Treatment system (ion exchange or reverse osmosis) to remove CCR constituents from groundwater and discharge under applicable permits | **Pump & Treat Long-Term**<br>Continue to operate hydraulic containment system to maintain reduction of CCR constituents in groundwater |
| *4* | CIP with Capping and Hydraulic Containment through Groundwater Pumping and Ex-Situ Treatment and Barrier Wall | CIP with Low Permeability Cap | **Barrier Wall with Hydraulic Containment**<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS using extraction wells and a low permeability barrier wall | | |
| *5* | Closure by Removal (CBR) with MNA | CBR | **Natural Attenuation with Monitoring**<br>Mitigate off-site migration of groundwater with CCR constituents above GWPS through process of natural attenuation | **No Active Treatment**<br>No active treatment technologies for groundwater to address CCR constituents | **MNA**<br>Long-term groundwater monitoring to confirm reduction of CCR constituents |

# APPENDIX A

# Groundwater Risk Evaluation

HALEY ALDRICH

www.haleyaldrich.com

# REPORT ON
# GROUNDWATER RISK EVALUATION
# NEW MADRID POWER PLANT
# POND 003
# NEW MADRID, MISSOURI

By

Haley & Aldrich, Inc.
Greenville, South Carolina

For

Associated Electric Cooperative, Inc.
Springfield, Missouri

File No. 129342-020
August 2019

## Table of Contents

**Figures**

**Attachment A** – Calculated Recreational Risk-Based Screening Levels

## List of Tables



## List of Figures

## List of Common Acronyms

| | |
|---|---|
| AECI | Associated Electric Cooperative, Inc. |
| AWQC | Ambient Water Quality Criteria |
| CCR | Coal Combustion Residuals |
| CFR | Code of Federal Regulations |
| CMA | Corrective Measures Assessment |
| CSM | Conceptual Site Model |
| DAF | Dilution Attenuation Factor |
| Haley & Aldrich | Haley & Aldrich, Inc. |
| HI | Hazard Index |
| GWPS | Groundwater Protection Standards |
| MCL | Maximum Contaminant Level |
| MDNR | Missouri Department of Natural Resources |
| mg/L | Milligram per Liter |
| RSL | Regional Screening Level |
| SL | Screening Level |
| SSI | Statistically Significant Increase |
| SSL | Statistically Significant Level |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Survey |

# 1. Introduction

The New Madrid Power Plant (NMPP) is a coal-fired power plant located on the Mississippi River in New Madrid, Missouri. The NMPP is an active energy production facility owned by Associated Electric Cooperative, Inc. (AECI) that generates electricity through coal combustion. The facility has been in operation since the 1970s. Pond 003 is a surface impoundment that encompasses approximately 110 acres and is located approximately 0.3 miles southeast of the NMPP plant site. **Figure 1** shows the location of the facility, and the location of Pond 003.

The U.S. Environmental Protection Agency (USEPA) issued a final rule for "Disposal of Coal Combustion Residuals from Electric Utilities" in 2015 (the CCR Rule) (USEPA, 2015). One of the requirements in the CCR Rule is that utilities monitor groundwater at coal ash management facilities, and that the data be reported publicly. NMPP is complying with the CCR Rule, and has posted the required information on their publicly-available website: https://www.aeci.org/clean/ccr/.

This "Groundwater Risk Evaluation" report has been prepared by Haley & Aldrich, Inc. (Haley & Aldrich), and is a companion document to the "Corrective Measures Assessment (CMA) for Pond 003 – New Madrid Power Plant." The purpose of this risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for Pond 003 under the CCR Rule.

Beyond the specific monitoring requirements of the CCR Rule, NMPP has also voluntarily taken the additional step to evaluate potential groundwater-to-surface water transport and exposure pathways through the development of risk-based groundwater screening levels that are protective of surface water in the Mississippi River. Details about the evaluation are provided below.

# 2. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the New Madrid Power Plant, including its location and where ash management has occurred at the facility. Information on where groundwater is located at the facility, the rate(s) of groundwater flow, the direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow are reviewed and summarized here.

A conceptual model was developed based on this physical setting information, and the model was used to identify what human populations could contact groundwater and/or surface water in the area of the facility. This information was also used to identify where ecological populations could come into contact with surface water.

Human health risk assessment is a process used to estimate the chance that contact with constituents in the environment may result in harm to people. Generally, there are four components to the process (USEPA, 1989): (1) Hazard Identification/Data Evaluation, (2) Toxicity Assessment, (3) Exposure Assessment, and (4) Risk Characterization.

The USEPA and other regulatory agencies, including the Missouri Department of Natural Resources (MDNR), develop "screening levels" of constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures. In developing screening levels, USEPA uses a specific target risk level (component 4) combined with an assumed exposure scenario (component 3) and toxicity information from USEPA (component 2) to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, (component 1) that is protective of a person in that exposure scenario (for example, drinking water). Similarly, ecological screening levels for surface water are developed by USEPA and MDNR to be protective of the wide range of potential aquatic ecological resources, or receptors.

Risk-based screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists, but indicate that further evaluation may be warranted.

Human health risk-based and ecological risk-based screening levels drawn from USEPA and MDNR sources are used to determine if the concentration levels of constituents in groundwater could pose a risk to human health or the environment that warrants further evaluation.

## 2.1 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. Some of the questions posed during the CSM evaluation include:

> What is the source? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? Are the constituent concentrations high enough to potentially exert a toxic effect?

For the evaluation of the ash management operations at the NMPP, the coal ash stored in Pond 003 is the potential source. Constituents present in the coal ash can be dissolved into infiltrating water (either from precipitation or from groundwater intrusion) that flows to groundwater, and those constituents may then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction.

The constituents derived from the coal ash could then be introduced to adjacent surface water bodies; here, that could be the Mississippi River. **Figure 1** shows the facility location and layout, identifies the location of Pond 003 and the adjacent surface water body, and shows the monitoring well locations. Thus, the environmental media of interest for this evaluation are:

- Groundwater on the facility; and
- Mississippi River surface water.

Pond 003 lies adjacent to the Mississippi River and the alluvial aquifer immediately beneath Pond 003 is in communication with the river. Seasonal changes in river stage cause the groundwater flow direction to change and occasionally reverse. Due to the influence of the adjacent Mississippi River, the groundwater flow in the alluvial aquifer is generally to the southwest during high river stage and generally to the northeast during low river stage. Due to the changing groundwater flow directions, monitoring wells were sited at locations to encircle Pond 003. **Figures 2 and 3** show the monitoring well networks and groundwater flow directions of the uppermost aquifer.

Groundwater downgradient of Pond 003 is not used for any purposes. An irrigation water supply well is located approximately 3500 feet to the south of Pond 003. However, that well is cross-gradient to primary groundwater flow direction and therefore would not receive groundwater discharge from Ponds 003 or 004. There are no construction activities presently occurring or planned within the uppermost aquifer in the foreseeable future. Therefore, there are no direct contact exposure pathways to groundwater downgradient of Pond 003.

The Mississippi River is not a source of drinking water in the downstream vicinity of NMPP; drinking water in New Madrid is provided by the City of New Madrid from groundwater wells. The nearest downstream water supply intake used for drinking water was identified at the Dow Chemical Plant in Iberville, Louisiana, approximately 675 miles downstream.

The Mississippi River can be used for human recreation – wading, swimming, boating, fishing and can serve as habitat for aquatic species – fish, amphibians, etc.

Thus, the potentially complete exposure pathways associated with CCR-related constituents in groundwater are:

- Direct contact with and ingestion of surface water (via migration of groundwater to surface water) during use of river water for a municipal water supply;
- Direct contact with surface water (via migration of groundwater to surface water) during recreational uses of the river; and
- Ingestion of biota (e.g., fish) that may uptake constituents that migrate from groundwater to surface water in the river.

A depiction of the conceptual site model is shown in **Figure 4**.

Based on this conceptual site model and the facility setting, samples collected from groundwater monitoring wells have been included in the evaluation. The samples have been analyzed for constituents that are commonly associated with CCR, as discussed below. However, it is recognized by the USEPA that all of these constituents can also be naturally occurring and can be found in rocks, soils, water and sediments; thus, it is necessary is to understand what the naturally occurring background levels are for these constituents. The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. The sampling is detailed in the next section.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?" health risk-based screening levels from USEPA and MDNR sources are used for comparison to the data, as described in Section 5.

# 3. Sample Collection and Analysis

## 3.1 GROUNDWATER SAMPLES

Twelve (12) groundwater monitoring wells were installed to evaluate shallow alluvial groundwater at Pond 003 under the CCR Rule: nine (9) monitoring wells were installed around the perimeter of Pond 003 to assess groundwater conditions at the ash management area, and three (3) monitoring wells were installed west of the facility to assess background groundwater conditions. **Figure 1** shows the locations of the monitoring wells. Each well is identified by a unique name. MW-6 through MW-9, and P-1 through P-5 are located around the perimeter of Pond 003, and B-123, B-126, and MW-16 are the three background wells that are used to identify upgradient/background conditions in groundwater. Each groundwater monitoring well was sampled thirteen (13) times[1].

## 3.2 SAMPLE ANALYSIS

The CCR Rule identifies the constituents that are included for groundwater testing; these are:

| | | |
|---|---|---|
| Boron | Antimony | Lead |
| Calcium | Arsenic | Lithium |
| Chloride | Barium | Mercury |
| pH | Beryllium | Molybdenum |
| Sulfate | Cadmium | Selenium |
| TDS | Chromium | Thallium |
| Fluoride | Cobalt | Radium 226/228 |

The CCR Rule requires eight (8) rounds of groundwater sampling and analysis be conducted for all wells to provide a baseline for current conditions. CCR groundwater monitoring has been performed between November 2016 and September 2018. Groundwater samples have been collected from each of the wells in the CCR monitoring well network and analyzed for USEPA Detection (Appendix III) and Assessment (Appendix IV) Monitoring Parameters. The CCR Rule requires statistical methods be used to determine whether a statistically significant increase (SSI) above background exists for the Appendix III (first column above) constituents. Based on the SSI results from the groundwater monitoring, additional assessment monitoring has been conducted. Section 1.3 of the "Corrective Measures Assessment (CMA)" report provides more detail on the objectives of the rounds of groundwater sampling. Appendix III and IV analytical results for the baseline and Assessment Monitoring events are summarized in **Table 1**.

# 4. Risk-Based Screening Levels

A comprehensive set of risk-based screening levels have been compiled for this evaluation for the three types of potential exposures identified in the conceptual site model discussion above:

- Human health drinking water consumption;

[1] The CCR Rule requires eight (8) rounds of sampling events to establish baseline conditions in each well. Under the CCR Rule, further rounds are defined as "Detection" sampling.

- Human health recreational use of surface water; and
- Aquatic ecological receptors for surface water.

It is important to note that the CCR Rule limits the evaluation of groundwater monitoring data of ash management areas to groundwater protection standards (GWPS), which are Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs (USEPA, 2018a) that are enforceable for municipal drinking water supplies, or to a comparison with site-specific background. GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on **Table 1**.

**Table 2** provides the human health drinking water and recreational screening levels for surface water available from the MDNR and USEPA sources. **Table 3** provides site-specific risk-based screening levels (RBSLs) derived for recreational exposure to surface water. **Table 4** provides the ecological surface water screening levels from MDNR and USEPA sources.

## 4.1 GROUNDWATER PROTECTION STANDARDS

The GWPS is defined in the CCR Rule at §257.95 Assessment monitoring program:

> (h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:
>
> > (1) For constituents for which a maximum contaminant level (MCL) has been established under §§141.62 and 141.66 of this title, the MCL for that constituent;
> > (2) For constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with § 257.91; or
> > (3) For constituents for which the background level is higher than the MCL identified under paragraph (h)(1) of this section, the background concentration.

USEPA published Amendments to the National Minimum Criteria Finalized in 2018 (Phase One, Part One) in the Federal Register on July 30, 2018 (USEPA, 2018b). This included revising the groundwater protection standard for constituents that do not have an established drinking water standard (or MCL) at §257.95 Assessment monitoring program (h) (2):

- Cobalt – 6 ug/L (micrograms per liter)
- Lead – 15 ug/L
- Lithium – 40 ug/L
- Molybdenum – 100 ug/l

GWPS used to evaluate potential drinking water exposures for CCR monitoring wells are shown on **Table 1**.

## 4.2 SCREENING LEVELS FOR THE PROTECTION OF SURFACE WATER

The GWPS are specific to the evaluation of groundwater at the CCR Rule monitoring wells. This section outlines the risk-based human health and ecological surface water screening levels that are protective of surface water in the Mississippi River.

Human health screening levels for surface water are identified for two exposure settings: 1) use of surface water as a drinking water source and the consumption of fish from a surface water body, and 2) recreational uses of surface water.

### 4.2.1 Drinking Water Screening Levels

The human health screening levels for drinking water are from Missouri state and USEPA sources and address the drinking water exposure pathway. The Missouri State drinking water supply levels are essentially the same as the Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs (USEPA, 2018a). The Missouri State groundwater screening levels provide some additional screening levels not included on their list of drinking water screening levels (MDNR, 2019) (**Table 2**). USEPA risk-based Regional Screening Level (RSLs) for tapwater (drinking water, or untreated groundwater used as potable water) have also been included for constituents which do not have promulgated Missouri/MCL criteria. The tapwater RSLs are based on USEPA default assumptions for residential exposure to tapwater (USEPA, 2019a). Missouri drinking water supply screening levels were used and supplemented with Federal MCLs, then the USEPA risk-based levels for tapwater (RSLs), where MDNR values were unavailable.

### 4.2.2 Published Recreational Screening Levels

Published human health screening levels for surface water are generally derived to be protective of the use of surface water as a drinking water source and the consumption of fish from a surface water body. The drinking water screening levels are also protective of, but highly conservative for, recreational uses of a surface water body (such as swimming or boating) because drinking water exposure is of a higher magnitude and frequency. The drinking water screening levels used to evaluate surface water, as discussed above, are protective for other recreational uses of the river such as swimming, wading, and boating. Note that this evaluation of other uses of surface water are above and beyond the requirements of the CCR Rule.

The human health screening levels for surface water are from federal and state sources and address the fish consumption pathway (where such values are available from the state) (**Table 2**). MDNR administers water quality standards for aquatic life (Missouri Code of State Regulations Division 20 Chapter 7 Table A) (MDNR, 2019). The fish consumption values for protection of human health are used for this assessment, and where unavailable the USEPA Ambient Water Quality Criteria (AWQC) for Human Health Consumption of Water and Organism are used (USEPA, 2019b).

### 4.2.3 Calculated Recreational Risk-Based Screening Levels

Site-specific RBSLs are essentially refined screening levels to account for receptor population characteristics and exposure pathways. As such, the site-specific RBSLs are less conservative, (i.e., more realistic), than screening levels and are, therefore, useful for evaluating whether COPCs may have the potential to pose health risks in excess of risk thresholds. For example, whereas surface water that is used as a recreational water body for swimming could be evaluated using drinking water standards which assume that people are drinking and bathing in the water daily, site-specific RBSLs for surface water will reflect incidental ingestion and dermal contact at an exposure rate and magnitude commensurate with swimming activities.

Potential exposures to constituents in surface water could, in general, occur through ingestion and dermal contact. However, the specific nature of the potential exposures is dependent on the type of water body. Specifically:

- Incidental ingestion and dermal contact with shallow surface water (e.g., less than two feet in depth) can only occur via wading because the water is not deep enough to permit swimming. Wading exposures could potentially occur in Little Pigeon Creek.

- Incidental ingestion and dermal contact with deeper surface water (e.g., more than three feet in depth) could occur via swimming. Exposures during swimming could be potentially complete in the Mississippi River; the water in Little Pigeon Creek is not deep enough to allow for swimming.

- Dermal contact with surface water could occur during boating or fishing activities in the Mississippi River. Since these types of activities are not associated with intense exposures to water (such as is the case with swimming), incidental ingestion of surface water would be insignificant.

RBSLs derived for recreational exposures to surface water for a recreational swimmer, wader, and boater are presented in **Table 3**. The RBSLs were calculated using USEPA-derived exposure factors and equations, as well as site-specific inputs where appropriate using the USEPA RSL calculator (USEPA, 2019c). The RBSL presented is the lower of the noncancer RBSL at a target noncancer hazard index of 1 and a target cancer-based risk of $10^{-5}$. The RSL calculator output, including the exposure parameters used, is provided in **Attachment A**.

### 4.2.4 Ecological Screening Levels

Ecological screening levels for surface water are published to provide a conservative estimate of the concentration to which an ecological receptor can be exposed without experiencing adverse effects. Due to the conservative methods used to derive published reference screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in any adverse effects to survival, growth and/or reproduction. Concentrations above ecological published screening levels for surface water, however, do not necessarily indicate that a potential ecological risk exists, but rather that further evaluation may be warranted.

**Table 4** presents the ecological published risk-based screening levels for surface water. Some of the screening levels are based on the hardness of the water, a default hardness value of 100 mg/L has been used, in accordance with USEPA and MDNR guidance. Note that this ecological evaluation of surface water is above and beyond the requirements of the CCR Rule.

Water quality criteria are concentrations calculated from controlled laboratory tests on freshwater or marine organisms that are protective of the most sensitive organism (often zooplankton such as daphnids) for the most sensitive life stage (typically reproduction).

MDNR administers water quality standards for aquatic life protective of the most sensitive aquatic life, and therefore protective for both direct contact of surface water by aquatic life, and potential exposures to wildlife through food chain uptake (Missouri Code of State Regulations Division 20 Chapter 7 Table A) (MDNR, 2019). Where MDNR values are unavailable, the USEPA AWQC Freshwater Chronic and Acute values are used (USEPA,2019d).

### 4.2.5 Selected Screening Levels

**Table 5** presents the selected human health and ecological screening levels (from **Tables 2 through 4**) and identifies the lowest selected screening level for surface water for the human health drinking water, human health recreational, and ecological potential exposure scenarios.

# 5. Results

The level of analysis and comparison to risk-based screening levels presented below is above and beyond the requirements of the CCR Rule. The analysis of the groundwater results required by the CCR Rule is presented in the "2018 Annual Groundwater Monitoring and Corrective Action Report" for NMPP Pond 003 [*https://www.aeci.org/media/4268/2019-0131_nmpp-annual-report_pond-003_final-cert.pdf*]. This report serves to supplement that report by providing the risk-based analysis of groundwater, so that the groundwater results can be understood in their broader environmental context.

## 5.1 SHALLOW ALLUVIAL AQUIFER GROUNDWATER – CCR RULE EVALUATION

AECI has filed reports and notification required by the federal CCR Rule on its website, as noted above, and additional reports will be prepared and posted on AECI's website per the CCR Rule. The statistical analysis of the data has indicated a statistically significant increased (SSI) concentration of Appendix III constituents in downgradient monitoring wells relative to concentrations observed in upgradient monitoring wells, for samples collected from monitoring wells MW-6 through MW-9, and P-1 through P-5 (see **Figure 1**) that monitor the shallow alluvial aquifer. Analytes exhibiting an SSI are a subset of the parameters identified in Section 4 and include boron, calcium, chloride, sulfate, and TDS. These results moved the groundwater sampling into the Assessment Monitoring phase.

Based on the assessment monitoring results, concentrations of molybdenum in some wells are statistically above the GWPS. These measured concentrations are then referred to as Statistically Significant Levels (SSLs). Therefore, the Assessment of Corrective Measures phase of the CCR Rule is triggered for these Appendix IV constituents.

Groundwater data from twelve rounds of sampling of the shallow alluvial aquifer groundwater were compared to the site-specific GWPS required by the CCR Rule. **Figure 1** shows that the monitoring wells are all located at the edge of Pond 003 and, therefore, provide worst-case groundwater results. **Table 1** compares the results of all CCR monitoring well sampling rounds to the GWPS. The vast majority of the results indicate concentration levels below the site-specific GWPS. A limited number of parameters are above the GWPS for some, but not all, sampling events.

The striking aspect of the analysis shown in **Table 1** is how few CCR monitoring well results are above a conservative GWPS based on MCLs, health-based GWPS, or background levels, given that the wells are located at the base of the ash management area, and the facility has been in operation for over 40 years Out of the 1,575 groundwater analyses conducted, only 85 results are above the GWPS (see **Table 1**). Put another way, approximately 95% of the groundwater results for the CCR Rule monitoring wells located at the edge of Pond 003 (MW-6 through MW-9, and P-1 through P-5) are below the GWPS. Even for the very few results that may be above screening values for some of the sampling events, including the SSI and SSL results identified under the CCR Rule, there is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk.

The SSI and SSL values reflect a statistical evaluation that mathematically compares the results of the various rounds of samples to background water quality and GWPS as required under the CCR rule. However, such values without further evaluation do not establish that there is an actual adverse impact to human health or the environment. The CSM process and screening analysis described in this report provide the relevant context for such groundwater monitoring results and whether Pond 003 poses a true risk to human health and the environment. As explained in the remaining sections of this report, based upon the application of risk assessment principles uniformly adopted by USEPA, no such risk exists.

# 6. Derivation of Risk-Based Screening Levels for Groundwater

NMPP is located on the Mississippi River – a major river system with a massive and rapid river flow. In this section, we have attempted to illustrate how the groundwater – which is a fraction of the volume and flow rate of the river – may interact with the Mississippi River under an assumed set of criteria and conditions. Such an exercise in assumptions can help put in context whether a theoretical risk to river water and its uses exists.

However, impacts to groundwater do not mean that surface waters are impaired. The degree of interface between groundwater and surface waters is variable and complex and dependent upon a variety of factors including gradient and flow rate. It is possible, however, to determine the maximum concentration level that would need to be present on-site in groundwater and still be protective of the surface water environment, assuming gradient and flow rates are such that groundwater flows into the surface water. Groundwater and surface waters flow at very different rates and volumes. The Mississippi River is the largest river system in North America and as depicted on **Table 6** and **Section 6.1**, as groundwater flows into the river, it is diluted by more than 100,000 times.

## 6.1 DERIVATION OF DILUTION ATTENUATION FACTOR

To estimate river surface water concentrations, a dilution attenuation factor (DAF) that accounts for groundwater flux (at the river edge (land) and river interface)[2] and subsequent mixing with surface

[2] Groundwater flux as defined by 10 CFR Part 960.2 is the rate of groundwater flow per unit area of porous media measured perpendicular to the direction of flow (in this case the Mississippi River down gradient of Pond 3).

water was calculated, and then applied to the representative groundwater concentrations.

The DAF was calculated using information for the upper most aquifer as provided in the site hydrological characterization report (Haley & Aldrich, 2017):

- Groundwater Flow ($Q_{groundwater}$): Approximately 3,114 $ft^3$/day
- River Flow ($Q_{river}$): Obtained from the USGS gauging station near New Madrid (Station #07024175). The station reported an annual average flow of 4.81 x $10^{10}$ $ft^3$/day.

Using these two values, the DAF is calculated to be 1.5 x $10^7$ [i.e., meaning that the ratio of the volume of river flow is seven orders of magnitude greater than the flow volumes attributed to groundwater per unit area ($Q_{river}$ / $Q_{groundwater}$)].

This calculation uses the most conservative values for groundwater flow (i.e., meaning the upper limits or reasonable maximum values of flow anticipated) because they use the maximum gradient, K values, and aquifer thicknesses, which in turn 'maximizes' the groundwater flux estimate. In addition, because the river stage is in direct connection with the aquifer unit, groundwater flow varies based on Low River Stage (groundwater flow toward river) and High River Stage (groundwater flow away from river). Consequently, groundwater does not migrate to the river year-round, but rather migrates to the river only during lower river stages. For the purposes of conservatism, this lower river stage (where groundwater flowing from Pond 003 to the river) was used in support of the subject risk screening. Although the calculations use conservative assumptions, the calculated dilution factor was rounded down to 100,000 as an additional measure of conservatism.

The representative surface water concentrations derived using the DAF are provided in **Table 6**. **Figure 5** provides an illustration of the DAF calculation and its relation to Pond 003.

## 6.2 RISK-BASED SCREENING LEVELS FOR GROUNDWATER

It is possible to calculate a protective screening level for groundwater based upon the amount of dilution that occurs under the above assumption. This calculated risk-based screening level for groundwater can be used to determine whether an on-site groundwater concentration level is protective of the river. Stated differently, at what concentration level does groundwater entering the river system pose a human health or ecological risk?

**Table 6** is summarized below and shows the application of the dilution factor to calculate risk-based groundwater screening levels that are protective for surface water, for Appendix III and Appendix IV constituents with risk-based screening levels available. For each constituent, the selected human health drinking water and recreational screening levels, as well as the ecological screening levels (from **Table 5**) are presented. The lowest of the three screening levels is then identified for surface water. The dilution factor is then applied to this lowest screening level for surface water to result in the groundwater screening level that is protective for surface water, which is what is shown in the table below.

This evaluation is not limited to only those constituents for which SSIs and SSLs have been identified. The constituents listed in **Table 6** are those for which there is one or more detected groundwater result with available risk-based screening levels.

The groundwater risk-based screening levels are calculated in units of milligrams of constituent per liter of water (mg/L). One mg/L is equivalent to one million parts per million.

The table identifies the maximum groundwater concentration of each constituent detected in Pond 003 monitoring wells. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values. This margin is shown in the last column of the table. To illustrate, concentration levels of molybdenum would need to be more than 2,500 times higher than currently measured levels before an adverse impact in the river could occur.

**CALCULATING RISK-BASED SCREENING LEVELS FOR GROUNDWATER (see Table 6)**

| **Dilution Attenuation Factor** | | **100,000** | | | |
|---|---|---|---|---|---|
| **Constituent** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Target Groundwater Screening Level - Mississippi River (mg/L)** | **Maximum Groundwater Concentration (mg/L)** | | **Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration** |
| **Detection Monitoring - USEPA Appendix III Constituents** | | | | | |
| Boron | 2 | 200,000 | 20 | MW-7 | 10,000 |
| Fluoride | 4 | 400,000 | 0.679 | P-2 | >580,000 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | |
| Antimony | 0.006 | 600 | 0.0031 | P-1 | >190,000 |
| Arsenic | 0.00014 | 14 | 0.011 | P-5 | >1,000 |
| Barium | 2 | 200,000 | 0.181 | MW-7 | >1,000,000 |
| Beryllium | 0.004 | 400 | 0.001 U | | NA |
| Cadmium | 0.0007 | 72 | 0.0016 | MW-7 | >44,000 |
| Chromium (Total) | 0.07 | 7,411 | 0.018 | P-1 | >410,000 |
| Cobalt | 0.178 | 17,800 | 0.0098 | MW-7 | >1,000,000 |
| Lead | 0.0025 | 252 | 0.0047 | P-3 | >53,000 |
| Lithium | 0.04 | 4,000 | 0.05 | P-4 | 80,000 |
| Mercury | 0.00077 | 77 | <0.00020 | | NA |
| Molybdenum | 0.1 | 10,000 | 3.9 | MW-7 | >2,500 |
| Selenium | 0.005 | 500 | 0.008 | P-3 | >62,000 |
| Thallium | 0.002 | 200 | 0.002 | MW-7 | 100,000 |
| **Radiological (pCi/L)** | | | | | |
| Radium-226 & 228 | 5 | 500,000 | 3.8 | MW-7 | >130,000 |

*** Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.**

This means that not only do the present concentrations of constituents in groundwater at Pond 003 not pose a risk to human health or the environment, but even much higher concentrations in groundwater would not be harmful.

# 7. Summary

This comprehensive evaluation demonstrates that there are no adverse impacts on human health or the environment from groundwater uses resulting from coal ash management practices at the AECI NMPP.

These conclusions are supported by the analysis provided in this report, which indicates that:

- There are no uses or activities that would result in direct exposure to the groundwater that contains detections of Appendix IV constituents.
- The only potentially complete exposure pathways to constituents in groundwater are associated with migration of the groundwater to surface water in the Mississippi River; the surface water is used as a source of drinking water, for recreational uses including fishing, and as habitat for aquatic organisms. Assuming that groundwater migrates to river surface water, the calculated concentrations of groundwater constituents in river surface water are orders of magnitude lower than screening levels protective for use of the river as drinking water, consumption of fish, and protection of aquatic life.

# References

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# TABLES

**TABLE 1**
**COMPARISON OF AECI NEW MADRID POWER PLANT POND 003 COMPLEX GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS – NOVEMBER 2016 THROUGH SEPTEMBER 2018 SAMPLING EVENTS**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| Monitoring Well ID | | Date Sampled | pH field | Chloride | Fluoride | Sulfate | Solids Total Dissolved | Antimony Total | Arsenic Total | Barium Total | Beryllium Total | Boron Total | Cadmium Total | Calcium Total | Chromium Total | Cobalt Total | Lead Total | Lithium Total | Mercury Total | Molybdenum Total | Selenium Total | Thallium Total | Radium-226 | Radium-228 | Combined Radium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | pCi/L | pCi/L |
| | Site GWPS (a) | | NA | NA | 4.0 | NA | NA | 0.006 | 0.01 | 2 | 0.004 | NA | 0.005 | NA | 0.1 | 0.006 | 0.015 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | NA | NA | 5 |
| Up Gradient | MW-16 | 11/2/2016 | 6.82 | 11 | 1.22 | 118 | 516 | <0.0010 | 0.0026 | 0.773 | <0.0010 | 0.0425 | <0.0010 | 157 | <0.0010 | <0.0050 | <0.0010 | 0.0263 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.26 | 1.59 | 1.85 |
| | | 12/9/2016 | 6.89 | 15 | 1.37 | 107 | 630 | <0.0010 | 0.0029 | 0.783 | <0.0010 | 0.0431 | <0.0010 | 154 | <0.0010 | <0.0050 | <0.0010 | 0.0274 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.13 | 0.85 | 0.98 |
| | | 1/7/2017 | 7.58 | 13 | 1.1 | 120 | 580 | <0.0030 | 0.0027 | 0.8 | <0.0010 | 0.039 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.033 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 1.46 | 0.883 | 2.343 |
| | | 1/30/2017 | 7.4 | 11 | 1.55 | 120 | 570 | <0.0030 | 0.0026 | 0.73 | <0.0010 | 0.037 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.856 | 0.921 | 1.777 |
| | | 2/21/2017 | 6.91 | 12 | 1.18 | 95 | 560 | <0.0030 | 0.0025 | 0.76 | <0.0010 | 0.051 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | -0.066 | 1.16 | 1.16 |
| | | 3/28/2017 | 6.88 | 11 | 1.44 | 100 | 580 | <0.0030 | 0.0025 | 0.76 | <0.0010 | 0.047 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.702 | 1.63 | 2.332 |
| | | 4/27/2017 | 6.97 | 12 | 1.38 | 93 | 560 | <0.0030 | 0.0025 | 0.76 | <0.0010 | 0.06 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.653 | 1.19 | 1.843 |
| | | 5/18/2017 | 6.88 | 13 | 1.59 | 97 | 600 | <0.0030 | 0.0027 | 0.75 | <0.0010 | 0.046 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.033 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.814 | 1.12 | 1.934 |
| | | 6/24/2017 | 7.02 | 11 | 1.18 | 110 | 490 | <0.0030 | 0.002 | 0.72 | <0.0010 | 0.036 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.825 | 0.962 | 1.787 |
| | | 8/15/2017 | 6.89 | 10 | 1.27 | 98 | 500 | <0.0030 | 0.0021 | 0.7 | <0.0010 | 0.052 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.033 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.336 | 1.06 | 1.396 |
| | | 3/15/2018 | 7.03 | 12 | 1.45 | 84 | 580 | | | | | 0.054 | | 140 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | 0.002 | 0.72 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | 0.0045 | <0.0010 | <0.0010 | 0.963 | 1.64 | 2.603 |
| | | 9/12/2018 | 6.99 | 16 | 1.2 | 73 | 400 | -- | 0.0023 | 0.69 | -- | 0.051 | -- | 150 | <0.0040 | <0.00086 | <0.0010 | 0.019 | -- | <0.0010 | <0.0010 | -- | 2.19 | 0.594 | 2.78 |
| | B-123 | 11/6/2016 | 7.16 | <5 | 0.52 | 34 | 394 | <0.0010 | 0.0024 | 0.239 | <0.0010 | 0.0261 | <0.0010 | 94.3 | <0.0010 | <0.0050 | <0.0010 | 0.0276 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.38 | 0.59 | 0.97 |
| | | 12/12/2016 | 7 | <5 | 0.57 | 37 | 448 | <0.0010 | 0.0011 | 0.206 | <0.0010 | 0.0201 | <0.0010 | 91 | <0.0010 | <0.0050 | <0.0010 | 0.0274 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.07 | 0.64 | 0.71 |
| | | 1/8/2017 | 7.53 | 5.6 | 0.446 | 48 | 340 | <0.0030 | 0.0014 | 0.21 | <0.0010 | 0.031 | <0.0010 | 89 | <0.0040 | <0.0020 | <0.0010 | 0.033 | <0.00020 | 0.003 | <0.0010 | <0.0010 | 0.156 | 0.485 | 0.641 |
| | | 1/24/2017 | 7.88 | 2.8 | 0.523 | 35 | 410 | <0.0030 | 0.0017 | 0.2 | <0.0010 | 0.014 | <0.0010 | 87 | <0.0040 | <0.0020 | <0.0010 | 0.032 | 0.00087 | 0.0035 | <0.0010 | <0.0010 | 0.542 | 0.518 | 1.06 |
| | | 2/23/2017 | 7.22 | 3 | 0.54 | 36 | 400 | <0.0030 | 0.0023 | 0.22 | <0.0010 | 0.031 | <0.0010 | 90 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | 0.0036 | <0.0010 | <0.0010 | 0 | 1.37 | 1.37 |
| | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| | | 4/25/2017 | 7.36 | 3.4 | 0.532 | 36 | 400 | <0.0030 | 0.0025 | 0.24 | <0.0010 | 0.032 | <0.0010 | 83 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.0036 | <0.0010 | <0.0010 | 0.429 | 0.398 | 0.827 |
| | | 5/16/2017 | 7.22 | 3.2 | 0.302 | 33 | 380 | <0.0030 | 0.002 | 0.21 | <0.0010 | 0.023 | <0.0010 | 77 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | 0.0036 | <0.0010 | <0.0010 | 0.492 | 0.858 | 1.35 |
| | | 6/21/2017 | 7.28 | 3.1 | 0.429 | 32 | 380 | <0.0030 | 0.0017 | 0.19 | <0.0010 | 0.029 | <0.0010 | 78 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.0036 | <0.0010 | <0.0010 | 0 | 0.668 | 0.668 |
| | | 8/28/2017 | 7.24 | 3.5 | 0.574 | 32 | 360 | <0.0030 | 0.002 | 0.2 | <0.0010 | 0.03 | <0.0010 | 82 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.0034 | <0.0010 | <0.0010 | 0.896 | 1.03 | 1.926 |
| | | 3/14/2018 | 7.35 | 3.3 | 0.547 | 32 | 370 | | | | | 0.023 | | 79 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | 0.0022 | 0.21 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.026 | <0.00020 | 0.0044 | <0.0010 | <0.0010 | 0.671 | 1.13 | 1.801 |
| | | 9/11/2018 | 7.36 | 3.7 | 0.521 | 31 | 330 | -- | 0.004 | 0.27 | -- | 0.027 | -- | 87 | <0.0040 | <0.00086 | <0.0010 | 0.019 | -- | 0.004 | <0.0010 | -- | 0.604 | 0.968 | 1.57 |
| | B-126 | 11/6/2016 | 6.9 | 8 | 0.39 | 57 | 560 | <0.0010 | 0.0099 | 0.4 | <0.0010 | 0.0342 | <0.0010 | 140 | <0.0010 | <0.0050 | <0.0010 | 0.0159 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.7 | -0.1 | 0.7 |
| | | 12/12/2016 | 6.68 | 11 | 0.39 | 173 | 826 | <0.0010 | 0.0076 | 0.447 | <0.0010 | 0.0273 | <0.0010 | 178 | 0.0013 | <0.0050 | <0.0010 | 0.0244 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.28 | 0.83 | 1.11 |
| | | 1/8/2017 | 7.49 | 6.4 | 0.376 | 43 | 240 | <0.0030 | 0.0063 | 0.25 | <0.0010 | 0.034 | <0.0010 | 72 | <0.0040 | 0.002 | 0.0011 | 0.016 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0 | 0.342 | 0.342 |
| | | 1/24/2017 | 7.37 | 3.4 | 0.457 | 26 | 290 | <0.0030 | 0.005 | 0.23 | <0.0010 | 0.018 | <0.0010 | 64 | <0.0040 | <0.0020 | <0.0010 | 0.013 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0 | -0.189 | 0 |
| | | 2/23/2017 | 7 | 7.4 | 0.525 | 58 | 340 | <0.0030 | 0.0067 | 0.28 | <0.0010 | 0.034 | <0.0010 | 85 | <0.0040 | 0.0021 | <0.0010 | 0.015 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.578 | 0.578 | 1.156 |
| | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| | | 4/25/2017 | 6.95 | 4.5 | 0.388 | 27 | 300 | <0.0030 | 0.0084 | 0.21 | <0.0010 | 0.032 | <0.0010 | 57 | 0.0047 | 0.0026 | 0.002 | 0.013 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.441 | 0.826 | 1.267 |
| | | 5/16/2017 | 6.93 | 1.7 | 0.258 | 5.6 | 170 | <0.0030 | 0.0085 | 0.13 | <0.0010 | 0.022 | <0.0010 | 35 | <0.0040 | <0.0020 | <0.0010 | <0.010 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.871 | 0.956 | 1.827 |
| | | 6/21/2017 | 6.91 | 3.2 | 0.398 | 7.6 | 210 | <0.0030 | 0.0094 | 0.16 | <0.0010 | 0.031 | <0.0010 | 41 | <0.0040 | <0.0020 | <0.0010 | <0.010 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 0.116 | 0.394 | 0.51 |
| | | 8/28/2017 | 6.94 | 4.6 | 0.493 | 20 | 270 | <0.0030 | 0.0097 | 0.21 | <0.0010 | 0.036 | <0.0010 | 63 | <0.0040 | <0.0020 | <0.0010 | 0.01 | <0.00020 | <0.0010 | <0.0010 | <0.0010 | 1 | 1.01 | 2.01 |
| | | 3/14/2018 | 7 | 3.6 | 0.369 | 26 | 280 | | | | | 0.032 | | 82 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | 0.0086 | 0.24 | <0.0010 | | <0.0010 | | 0.0094 | 0.003 | 0.0043 | 0.013 | <0.00020 | 0.0014 | 0.0012 | <0.0010 | 0.079 | 2.12 | 2.199 |
| | | 9/11/2018 | 7 | 1 | 0.284 | 11 | 440 | -- | 0.0052 | 0.31 | -- | 0.034 | -- | 130 | <0.0040 | 0.0019 | <0.0010 | 0.011 | -- | <0.0010 | <0.0010 | -- | 1.01 | 0.116 | 1.126 |
| Down Gradient | MW-6 | 11/3/2016 | 6.78 | <5 | 0.36 | 63 | 486 | <0.0010 | <0.0010 | 0.131 | <0.0010 | 0.421 | <0.0010 | 139 | <0.0010 | <0.0050 | <0.0010 | 0.0168 | <0.00020 | <0.0100 | <0.0010 | <0.0010 | 0.02 | 0.75 | 0.77 |
| | | 12/6/2016 | 6.92 | 8 | 0.32 | 84 | 530 | <0.0010 | 0.0022 | 0.137 | <0.0010 | 0.486 | <0.0010 | 136 | 0.0022 | <0.0050 | <0.0010 | 0.0181 | <0.00020 | 0.0417 | <0.0010 | <0.0010 | 0.779 | 0.78 | 1.559 |
| | | 1/4/2017 | 7.39 | 6.7 | 0.536 | 95 | 570 | <0.0030 | 0.0012 | 0.14 | <0.0010 | 0.53 | <0.0010 | 120 | <0.0040 | 0.0036 | <0.0010 | 0.023 | <0.00020 | 0.046 | <0.0010 | <0.0010 | 0.406 | 0.858 | 1.264 |
| | | 1/26/2017 | 7.44 | 4.5 | 0.564 | 91 | 340 | <0.0030 | 0.0019 | 0.16 | <0.0010 | 0.75 | <0.0010 | 150 | <0.0040 | 0.0033 | <0.0010 | 0.021 | <0.00020 | 0.071 | <0.0010 | <0.0010 | 0.617 | 1.3 | 1.917 |
| | | 2/21/2017 | 6.9 | <5.0 | 0.308 | 63 | 500 | <0.0030 | 0.001 | 0.16 | <0.0010 | 0.75 | <0.0010 | 140 | <0.0040 | 0.0047 | <0.0010 | 0.021 | <0.00020 | 0.034 | <0.0010 | <0.0010 | 0.119 | 0.946 | 1.065 |
| | | 3/28/2017 | 6.78 | 7 | 0.519 | 100 | 600 | <0.0030 | <0.0010 | 0.17 | <0.0010 | 0.86 | <0.0010 | 130 | <0.0040 | 0.0046 | <0.0010 | 0.022 | <0.00020 | 0.033 | <0.0010 | <0.0010 | 0.279 | 0.807 | 1.086 |
| | | 4/27/2017 | 7.05 | 9 | 0.328 | 140 | 680 | <0.0030 | 0.0016 | 0.18 | <0.0010 | 1.6 | <0.0010 | 170 | <0.0040 | 0.0041 | <0.0010 | 0.019 | <0.00020 | 0.085 | <0.0010 | <0.0010 | 0.323 | 1.01 | 1.333 |
| | | 5/18/2017 | 6.9 | 10 | <0.250 | 150 | 660 | <0.0030 | <0.0010 | 0.18 | <0.0010 | 1.8 | <0.0010 | 150 | <0.0040 | 0.005 | <0.0010 | 0.023 | <0.00020 | 0.048 | <0.0010 | <0.0010 | 0.652 | 0.398 | 1.05 |
| | | 6/20/2017 | 6.94 | 11 | 0.362 | 150 | 640 | <0.0030 | 0.0012 | 0.16 | <0.0010 | 1.7 | <0.0010 | 150 | <0.0040 | 0.0054 | <0.0010 | 0.022 | <0.00020 | 0.021 | 0.001 | <0.0010 | 1.32 | 1.07 | 2.39 |
| | | 8/16/2017 | 6.84 | 7 | 0.316 | 89 | 500 | <0.0030 | <0.0010 | 0.15 | <0.0010 | 1 | <0.0010 | 170 | <0.0040 | 0.006 | <0.0010 | 0.024 | <0.00020 | 0.01 | <0.0010 | <0.0010 | 0.884 | 0.767 | 1.651 |
| | | 3/15/2018 | 7.05 | 9 | 0.446 | 110 | 540 | | | | | 2.1 | | 120 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | <0.0010 | 0.16 | <0.0010 | | <0.0010 | | <0.0040 | 0.0052 | <0.0010 | 0.018 | <0.00020 | 0.063 | <0.0010 | <0.0010 | 0.122 | 0.558 | 0.68 |
| | | 9/11/2018 | 7.09 | 7 | 0.319 | 64 | 380 | -- | <0.0010 | 0.11 | -- | 0.66 | -- | 130 | <0.0040 | 0.0028 | <0.0010 | <0.010 | -- | 0.042 | <0.0010 | -- | 0.41 | 0.38 | 0.79 |

**TABLE 1**
**COMPARISON OF AECI NEW MADRID POWER PLANT POND 003 COMPLEX GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS – NOVEMBER 2016 THROUGH SEPTEMBER 2018 SAMPLING EVENTS**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| Monitoring Well ID | | Date Sampled | pH field | Chloride | Fluoride | Sulfate | Solids Total Dissolved | Antimony Total | Arsenic Total | Barium Total | Beryllium Total | Boron Total | Cadmium Total | Calcium Total | Chromium Total | Cobalt Total | Lead Total | Lithium Total | Mercury Total | Molybdenum Total | Selenium Total | Thallium Total | Radium-226 | Radium-228 | Combined Radium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | pCi/L | pCi/L |
| | Site GWPS (a) | | NA | NA | 4.0 | NA | NA | 0.006 | 0.01 | 2 | 0.004 | NA | 0.005 | NA | 0.1 | 0.006 | 0.015 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | NA | NA | 5 |
| Down Gradient | MW-7 | 11/3/2016 | 6.75 | 7 | 0.34 | 409 | 1080 | <0.0010 | 0.0021 | 0.181 | <0.0010 | 19.9 | <0.0010 | 232 | <0.0010 | **0.0062** | <0.0010 | 0.0223 | <0.00020 | **3.2** | <0.0010 | <0.0010 | 0.09 | 1.04 | 1.13 |
| | | 12/6/2016 | 6.88 | 6 | 0.33 | 320 | 952 | <0.0010 | 0.0032 | 0.15 | <0.0010 | 18.4 | 0.0011 | 207 | <0.0010 | **0.0098** | <0.0010 | 0.0227 | <0.00020 | **3.24** | <0.0010 | <0.0010 | 0.175 | 0.922 | 1.097 |
| | | 1/4/2017 | 7.23 | 7.2 | 0.464 | 360 | 810 | <0.0030 | 0.0045 | 0.11 | <0.0010 | 17 | 0.0012 | 120 | <0.0040 | **0.0067** | <0.0010 | 0.031 | <0.00020 | **2.8** | <0.0010 | <0.0010 | 0.389 | 0.89 | 1.279 |
| | | 1/26/2017 | 7.62 | 7.9 | 0.564 | 310 | 720 | <0.0030 | 0.0036 | 0.12 | <0.0010 | 14 | 0.0016 | 120 | <0.0040 | 0.0059 | <0.0010 | 0.027 | <0.00020 | **2.9** | <0.0010 | <0.0010 | 0.345 | 0.43 | 0.775 |
| | | 2/22/2017 | 6.88 | 7.6 | 0.287 | 380 | 960 | <0.0030 | 0.0021 | 0.15 | <0.0010 | 19 | <0.0010 | 200 | <0.0040 | **0.0068** | <0.0010 | 0.03 | <0.00020 | **3.4** | <0.0010 | <0.0010 | 2.97 | 0.829 | 3.799 |
| | | 3/30/2017 | 6.78 | 7.4 | 0.496 | 390 | 980 | <0.0030 | 0.0018 | 0.15 | <0.0010 | 17 | <0.0010 | 180 | <0.0040 | **0.0067** | <0.0010 | 0.028 | <0.00020 | **3.4** | <0.0010 | <0.0010 | 0.244 | 1.16 | 1.404 |
| | | 4/26/2017 | 7.02 | 9.3 | 0.277 | 370 | 900 | <0.0030 | 0.0034 | 0.14 | <0.0010 | 20 | 0.0014 | 180 | <0.0040 | 0.0051 | <0.0010 | 0.027 | <0.00020 | **3.9** | <0.0010 | <0.0010 | 0.335 | 1.39 | 1.725 |
| | | 5/18/2017 | 6.85 | 10 | <0.250 | 420 | 960 | <0.0030 | 0.0037 | 0.14 | <0.0010 | 20 | <0.0010 | 170 | <0.0040 | 0.003 | <0.0010 | 0.034 | <0.00020 | **3.9** | <0.0010 | <0.0010 | 0.767 | 1.95 | 2.717 |
| | | 6/20/2017 | 6.99 | 5.7 | 0.388 | 300 | 960 | <0.0030 | 0.0028 | 0.15 | <0.0010 | 19 | 0.0016 | 190 | <0.0040 | **0.007** | 0.0018 | 0.028 | <0.00020 | **3.5** | 0.0021 | 0.002 | 0.544 | 1.17 | 1.714 |
| | | 8/16/2017 | 7.16 | 6.6 | 0.41 | 290 | 720 | <0.0030 | 0.002 | 0.17 | <0.0010 | 16 | <0.0010 | 210 | <0.0040 | **0.0073** | <0.0010 | 0.031 | <0.00020 | **3.6** | <0.0010 | <0.0010 | 0.544 | 1 | 1.544 |
| | | 3/15/2018 | 7.01 | 9.9 | 0.372 | 340 | 830 | | | | | 16 | | 160 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | 0.0023 | 0.13 | <0.0010 | | <0.0010 | | <0.0040 | 0.0058 | <0.0010 | 0.019 | <0.00020 | **3.4** | <0.0010 | <0.0010 | 0.109 | 0.52 | 0.629 |
| | | 9/11/2018 | 7.2 | 13 | 0.33 | 470 | 880 | -- | 0.0024 | 0.14 | -- | 19 | -- | 200 | <0.0040 | **0.0076** | <0.0010 | 0.014 | -- | **3** | <0.0010 | -- | 0.218 | 1.14 | 1.358 |
| | MW-8 | 11/4/2016 | 6.99 | 7 | 0.29 | 419 | 1030 | <0.0010 | 0.004 | 0.115 | <0.0010 | 17.4 | <0.0010 | 233 | <0.0010 | <0.0050 | <0.0010 | 0.0197 | <0.00020 | **0.737** | <0.0010 | <0.0010 | 0.67 | 0.693 | 1.363 |
| | | 12/7/2016 | 7.09 | 6 | 0.29 | 443 | 1050 | <0.0010 | 0.0026 | 0.111 | <0.0010 | 19.8 | <0.0010 | 235 | <0.0010 | <0.0050 | <0.0010 | 0.0223 | <0.00020 | **0.706** | <0.0010 | <0.0010 | 0.494 | 0.965 | 1.459 |
| | | 1/5/2017 | 7.59 | 12 | 0.366 | 230 | 570 | <0.0030 | 0.0046 | 0.066 | <0.0010 | 12 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.023 | <0.00020 | **0.96** | <0.0010 | <0.0010 | -0.137 | 0.563 | 0.563 |
| | | 1/26/2017 | 7.8 | 12 | 0.538 | 300 | 690 | <0.0030 | 0.0045 | 0.085 | <0.0010 | 12 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.87** | <0.0010 | <0.0010 | -0.209 | 0.822 | 0.822 |
| | | 2/21/2017 | 7.11 | 9.6 | 0.288 | 320 | 840 | <0.0030 | 0.0057 | 0.1 | <0.0010 | 14 | <0.0010 | 190 | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | **0.83** | <0.0010 | <0.0010 | 0.871 | 1.42 | 2.291 |
| | | 3/30/2017 | 7.03 | 8.8 | 0.475 | 360 | 940 | <0.0030 | 0.0054 | 0.11 | <0.0010 | 15 | <0.0010 | 180 | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | **0.83** | <0.0010 | <0.0010 | 0.402 | 0.952 | 1.354 |
| | | 4/26/2017 | 7.26 | 11 | 0.3 | 270 | 660 | <0.0030 | 0.005 | 0.082 | <0.0010 | 14 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.018 | <0.00020 | **1** | <0.0010 | <0.0010 | 0.0534 | 0.959 | 1.0124 |
| | | 5/17/2017 | 7.12 | 9.5 | 0.348 | 300 | 740 | <0.0030 | 0.0062 | 0.098 | <0.0010 | 14 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **1.2** | <0.0010 | <0.0010 | 0.45 | 0.976 | 1.426 |
| | | 6/21/2017 | 7.23 | 9.5 | 0.361 | 340 | 720 | <0.0030 | 0.006 | 0.1 | <0.0010 | 15 | <0.0010 | 170 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.93** | <0.0010 | <0.0010 | 0.884 | 0.537 | 1.421 |
| | | 8/16/2017 | 7.15 | 9.1 | 0.376 | 330 | 700 | <0.0030 | 0.0048 | 0.1 | <0.0010 | 14 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | **1** | <0.0010 | <0.0010 | 0.239 | 0.674 | 0.913 |
| | | 3/15/2018 | 7.32 | 10 | 0.354 | 180 | 540 | | | | | 12 | | 120 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | 0.0053 | 0.082 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.017 | <0.00020 | **0.93** | <0.0010 | <0.0010 | 0.121 | 0.944 | 1.065 |
| | | 9/12/2018 | 7.2 | 10 | 0.29 | 320 | 700 | -- | 0.0045 | 0.082 | -- | 16 | -- | 180 | <0.0040 | 0.0016 | <0.0010 | 0.012 | -- | **0.86** | <0.0010 | -- | 0.518 | 0.322 | 0.84 |
| Down Gradient | MW-9 | 11/4/2016 | 7.15 | 17 | 0.53 | 108 | 534 | <0.0010 | <0.0010 | 0.0984 | <0.0010 | 2.26 | <0.0010 | 123 | <0.0010 | <0.0050 | <0.0010 | 0.0258 | <0.00020 | **0.312** | <0.0010 | <0.0010 | -0.09 | 3.12 | 3.12 |
| | | 12/7/2016 | 7.22 | 16 | 0.49 | 109 | 476 | <0.0010 | <0.0010 | 0.0842 | <0.0010 | 3.08 | <0.0010 | 119 | <0.0010 | <0.0050 | <0.0010 | 0.0296 | <0.00020 | **0.337** | 0.0015 | <0.0010 | 0.547 | 0.848 | 1.395 |
| | | 1/5/2017 | 7.55 | 16 | 0.508 | 110 | 400 | <0.0030 | <0.0010 | 0.075 | <0.0010 | 2.8 | <0.0010 | 82 | <0.0040 | <0.0020 | <0.0010 | 0.034 | <0.00020 | **0.32** | <0.0010 | <0.0010 | 0.275 | 1.28 | 1.555 |
| | | 1/27/2017 | 8.13 | 17 | 0.557 | 120 | 420 | <0.0030 | <0.0010 | 0.072 | <0.0010 | 2.4 | <0.0010 | 82 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | **0.35** | <0.0010 | <0.0010 | 0.064 | 0.466 | 0.53 |
| | | 2/21/2017 | 7.29 | 17 | 0.481 | 96 | 500 | <0.0030 | <0.0010 | 0.089 | <0.0010 | 2.5 | <0.0010 | 120 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | **0.33** | <0.0010 | <0.0010 | 0.37 | 1.1 | 1.47 |
| | | 3/30/2017 | 7.15 | 18 | 0.654 | 110 | 490 | <0.0030 | <0.0010 | 0.08 | <0.0010 | 2.2 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | **0.33** | <0.0010 | <0.0010 | 0.403 | 1.02 | 1.423 |
| | | 4/26/2017 | 7.5 | 17 | 0.481 | 97 | 400 | <0.0030 | <0.0010 | 0.069 | <0.0010 | 1.9 | <0.0010 | 90 | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | **0.42** | <0.0010 | <0.0010 | 0.32 | 0.334 | 0.654 |
| | | 5/17/2017 | 7.27 | 19 | <0.250 | 97 | 480 | <0.0030 | <0.0010 | 0.098 | <0.0010 | 2.1 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | 0.034 | <0.00020 | **0.44** | <0.0010 | <0.0010 | 0.371 | 0.925 | 1.296 |
| | | 6/20/2017 | 7.33 | 17 | 0.507 | 110 | 540 | <0.0030 | <0.0010 | 0.092 | <0.0010 | 2 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | **0.36** | <0.0010 | <0.0010 | 0.183 | 0.526 | 0.709 |
| | | 8/16/2017 | 7.23 | 16 | 0.561 | 110 | 430 | <0.0030 | <0.0010 | 0.097 | <0.0010 | 2.2 | <0.0010 | 120 | <0.0040 | <0.0020 | <0.0010 | 0.035 | <0.00020 | **0.35** | <0.0010 | <0.0010 | 0.261 | 0.716 | 0.977 |
| | | 3/15/2018 | 7.41 | 20 | 0.386 | 100 | 410 | | | | | 2.1 | | 110 | | | | | | | | | | | |
| | | 5/30/2018 | | | | | | <0.0030 | <0.0010 | 0.089 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.026 | <0.00020 | **0.34** | <0.0010 | <0.0010 | 0 | 0.599 | 0.599 |
| | | 9/12/2018 | 7.34 | 20 | 0.44 | 110 | 470 | -- | <0.0010 | 0.074 | -- | 2.4 | -- | 110 | <0.0040 | <0.00086 | <0.0010 | 0.021 | -- | **0.34** | <0.0010 | -- | 0.147 | 0.0688 | 0.216 |
| | P-1 | 11/5/2016 | 7.05 | 19 | 0.38 | 178 | 632 | <0.0010 | <0.0010 | 0.0533 | <0.0010 | 2.04 | <0.0010 | 153 | <0.0010 | <0.0050 | <0.0010 | 0.0221 | <0.00020 | 0.0194 | 0.0014 | <0.0010 | -0.12 | 1.48 | 1.48 |
| | | 12/8/2016 | 7.25 | 19 | 0.44 | 170 | 610 | <0.0010 | <0.0010 | 0.0552 | <0.0010 | 1.99 | <0.0010 | 152 | <0.0010 | <0.0050 | <0.0010 | 0.0248 | <0.00020 | 0.0506 | <0.0010 | <0.0010 | NS | NS | NS |
| | | 1/6/2017 | 7.76 | 20 | 0.552 | 180 | 540 | <0.0030 | <0.0010 | 0.051 | <0.0010 | 2 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.028 | <0.00020 | 0.034 | <0.0010 | <0.0010 | 0 | 1.29 | 1.29 |
| | | 1/28/2017 | 7.68 | 20 | 0.516 | 220 | 560 | <0.0030 | <0.0010 | 0.053 | <0.0010 | 1.9 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.024 | 0.0062 | <0.0010 | -0.125 | 0.751 | 0.751 |
| | | 2/21/2017 | 7.24 | 17 | 0.364 | 220 | 720 | <0.0030 | <0.0010 | 0.065 | <0.0010 | 1.8 | <0.0010 | 170 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.013 | 0.0051 | <0.0010 | 0.386 | 0.889 | 1.275 |
| | | 3/30/2017 | 7.04 | 15 | 0.519 | 220 | 760 | <0.0030 | <0.0010 | 0.07 | <0.0010 | 1.7 | <0.0010 | 160 | 0.018 | <0.0020 | <0.0010 | 0.03 | <0.00020 | 0.011 | 0.0038 | <0.0010 | 0.419 | 1.12 | 1.539 |
| | | 4/26/2017 | 7.25 | 16 | 0.378 | 220 | 660 | 0.0031 | <0.0010 | 0.063 | <0.0010 | 1.8 | <0.0010 | 170 | 0.0051 | <0.0020 | <0.0010 | 0.026 | <0.00020 | 0.013 | 0.0037 | <0.0010 | 0.223 | 0.56 | 0.783 |
| | | 5/17/2017 | 7.06 | 17 | <0.250 | 220 | 660 | <0.0030 | <0.0010 | 0.068 | <0.0010 | 1.7 | <0.0010 | 160 | 0.0071 | <0.0020 | <0.0010 | 0.031 | <0.00020 | 0.015 | 0.0052 | <0.0010 | 0.974 | 1.01 | 1.984 |
| | | 6/21/2017 | 7.23 | 16 | 0.411 | 190 | 640 | <0.0030 | <0.0010 | 0.062 | <0.0010 | 1.5 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.027 | <0.00020 | 0.011 | 0.0054 | <0.0010 | 0.788 | 0.552 | 1.34 |
| | | 8/16/2017 | 7.21 | 16 | 0.416 | 200 | 540 | <0.0030 | <0.0010 | 0.055 | <0.0010 | 1.9 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | 0.011 | 0.0033 | <0.0010 | 0.25 | 0.379 | 0.629 |
| | | 3/15/2018 | 7.19 | 17 | 0.351 | 190 | 620 | | | | | 1.4 | | 150 | | | | | | | | | | | |
| | | 5/29/2018 | | | | | | <0.0030 | <0.0010 | 0.063 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | 0.013 | 0.0054 | <0.0010 | 0.434 | 0.33 | 0.764 |
| | | 9/12/2018 | 7.22 | 18 | 0.34 | 160 | 520 | -- | <0.0010 | 0.059 | -- | 1.6 | -- | 160 | 0.0071 | <0.00086 | <0.0010 | 0.02 | -- | 0.023 | 0.0044 | -- | 0.228 | 0.435 | 0.663 |
| | P-2 | 11/4/2016 | 7.03 | 17 | 0.52 | 384 | 816 | <0.0010 | <0.0010 | 0.0963 | <0.0010 | 3.18 | <0.0010 | 181 | <0.0010 | <0.0050 | <0.0010 | 0.0188 | <0.00020 | **0.279** | 0.0014 | <0.0010 | -0.19 | -2.08 | 0 |
| | | 12/7/2016 | 7.28 | 18 | 0.61 | 292 | 688 | <0.0010 | <0.0010 | 0.0888 | <0.0010 | 2.52 | <0.0010 | 164 | <0.0010 | <0.0050 | <0.0010 | 0.0174 | <0.00020 | **0.351** | 0.001 | <0.0010 | 0.746 | 1.3 | 2.046 |
| | | 1/5/2017 | 7.55 | 21 | 0.643 | 310 | 560 | <0.0030 | <0.0010 | 0.076 | <0.0010 | 1.6 | <0.0010 | 110 | <0.0040 | <0.0020 | <0.0010 | 0.02 | <0.00020 | **0.35** | <0.0010 | <0.0010 | 0.198 | 0.545 | 0.743 |
| | | 1/28/2017 | 7.62 | 19 | 0.662 | 300 | 620 | <0.0030 | <0.0010 | 0.075 | <0.0010 | 1.7 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.016 | <0.00020 | **0.34** | 0.0011 | <0.0010 | 0.183 | 0.549 | 0.732 |
| | | 2/21/2017 | 7.23 | 18 | 0.512 | 310 | 770 | <0.0030 | <0.0010 | 0.098 | <0.0010 | 2.4 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | **0.29** | 0.0012 | <0.0010 | 0.322 | 0.824 | 1.146 |
| | | 3/30/2017 | 7.09 | 18 | 0.679 | 320 | 780 | <0.0030 | <0.0010 | 0.094 | <0.0010 | 2.3 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.023 | <0.00020 | **0.29** | 0.0011 | <0.0010 | 0.64 | 0.693 | 1.333 |
| | | 4/26/2017 | 7.32 | 19 | 0.566 | 310 | 630 | <0.0030 | <0.0010 | 0.084 | <0.0010 | 2.2 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.018 | <0.00020 | **0.31** | <0.0010 | <0.0010 | 0.16 | 0.847 | 1.007 |
| | | 5/17/2017 | 7.2 | 19 | 0.306 | 300 | 660 | <0.0030 | <0.0020 | 0.082 | <0.0010 | 2.1 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.32** | <0.0020 | <0.0010 | 0.104 | 0.347 | 0.451 |
| | | 6/20/2017 | 7.26 | 18 | 0.534 | 310 | 780 | <0.0030 | 0.001 | 0.086 | <0.0010 | 2.3 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.27** | 0.0022 | <0.0010 | 0.593 | 0.878 | 1.471 |
| | | 8/17/2016 | 7.18 | 14 | 0.52 | 350 | 680 | <0.0030 | <0.0010 | 0.1 | <0.0010 | 2.7 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.028 | <0.00020 | **0.27** | 0.0014 | <0.0010 | 0 | 0.52 | 0.52 |
| | | 3/15/2018 | 7.33 | 19 | 0.519 | 350 | 800 | | | | | 2 | | 170 | | | | | | | | | | | |
| | | 6/1/2018 | | | | | | <0.0030 | <0.0010 | 0.096 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.02 | <0.00020 | **0.32** | 0.0015 | <0.0010 | 0.385 | 0.657 | 1.042 |
| | | 9/12/2018 | 7.41 | 21 | 0.561 | 240 | 510 | -- | <0.0010 | 0.067 | -- | 2.6 | -- | 140 | <0.0040 | <0.00086 | <0.0010 | <0.010 | -- | **0.32** | <0.0010 | -- | 0.376 | 0.052 | 0.428 |

**TABLE 1**
**COMPARISON OF AECI NEW MADRID POWER PLANT POND 003 COMPLEX GROUNDWATER MONITORING RESULTS TO SITE GROUNDWATER PROTECTION STANDARDS – NOVEMBER 2016 THROUGH SEPTEMBER 2018 SAMPLING EVENTS**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| Monitoring Well ID | | Date Sampled | pH field | Chloride | Fluoride | Sulfate | Solids Total Dissolved | Antimony Total | Arsenic Total | Barium Total | Beryllium Total | Boron Total | Cadmium Total | Calcium Total | Chromium Total | Cobalt Total | Lead Total | Lithium Total | Mercury Total | Molybdenum Total | Selenium Total | Thallium Total | Radium-226 | Radium-228 | Combined Radium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SU | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | pCi/L | pCi/L |
| | Site GWPS (a) | | NA | NA | 4.0 | NA | NA | 0.006 | 0.01 | 2 | 0.004 | NA | 0.005 | NA | 0.1 | 0.006 | 0.015 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | NA | NA | 5 |
| Down Gradient | P-3 | 11/4/2016 | 6.91 | 15 | 0.36 | 138 | 712 | <0.0010 | <0.0010 | 0.102 | <0.0010 | 8.83 | <0.0010 | 179 | <0.0010 | <0.0050 | <0.0010 | 0.025 | <0.00020 | **1.28** | 0.0041 | <0.0010 | 0.29 | -0.06 | 0.29 |
| | | 12/7/2016 | 7.03 | 11 | 0.48 | 155 | 750 | <0.0010 | <0.0010 | 0.111 | <0.0010 | 12.8 | <0.0010 | 191 | <0.0010 | <0.0050 | <0.0010 | 0.0285 | <0.00020 | **1.56** | 0.008 | <0.0010 | 0.226 | 0.807 | 1.033 |
| | | 1/5/2017 | 7.29 | 15 | 0.481 | 190 | 680 | <0.0030 | <0.0010 | 0.098 | <0.0010 | 13 | <0.0010 | 150 | <0.0040 | <0.0020 | <0.0010 | 0.033 | <0.00020 | **1.4** | 0.0046 | <0.0010 | 0.0691 | 0.646 | 0.7151 |
| | | 1/28/2017 | 7.86 | 13 | 0.463 | 160 | 610 | <0.0030 | <0.0010 | 0.1 | <0.0010 | 11 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.027 | <0.00020 | **1.3** | 0.0029 | <0.0010 | 0.389 | 0.382 | 0.771 |
| | | 2/21/2017 | 7.13 | 17 | 0.381 | 130 | 640 | <0.0030 | <0.0010 | 0.1 | <0.0010 | 9.3 | <0.0010 | 170 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | **1.2** | 0.0042 | <0.0010 | 0.927 | 0.473 | 1.4 |
| | | 3/30/2017 | 6.95 | 14 | 0.591 | 140 | 700 | <0.0030 | <0.0010 | 0.1 | <0.0010 | 8.9 | <0.0010 | 160 | <0.0040 | <0.0020 | 0.0047 | 0.03 | <0.00020 | **1.1** | 0.0048 | <0.0010 | -0.152 | 0.302 | 0.302 |
| | | 4/26/2017 | 7.19 | 14 | 0.463 | 150 | 660 | <0.0030 | <0.0010 | 0.1 | <0.0010 | 12 | <0.0010 | 190 | <0.0040 | <0.0020 | <0.0010 | 0.027 | <0.00020 | **1.4** | 0.0036 | <0.0010 | 0.181 | 0.306 | 0.487 |
| | | 5/17/2017 | 7 | 16 | <0.250 | 130 | 640 | <0.0030 | <0.0010 | 0.093 | <0.0010 | 7.8 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.032 | <0.00020 | **1.1** | 0.0037 | <0.0010 | 0.449 | 0.41 | 0.859 |
| | | 6/20/2017 | 7.13 | 15 | 0.461 | 130 | 640 | <0.0030 | <0.0010 | 0.095 | <0.0010 | 8.7 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | **1** | 0.006 | <0.0010 | 0.439 | 1.21 | 1.649 |
| | | 8/16/2017 | 7.1 | 15 | 0.482 | 120 | 550 | <0.0030 | <0.0010 | 0.098 | <0.0010 | 8.7 | <0.0010 | 160 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | **1.3** | 0.0046 | <0.0010 | 0.274 | 0.729 | 1.003 |
| | | 3/15/2018 | 7.32 | 18 | 0.562 | 120 | 620 | | | | | 6.2 | | 140 | | | | | | | | | | | |
| | | 5/29/2018 | | | | | | <0.0030 | <0.0010 | 0.095 | <0.0010 | | <0.0010 | | 0.0048 | <0.0020 | 0.0016 | 0.023 | <0.00020 | **1.3** | 0.0054 | <0.0010 | 0.322 | 0.282 | 0.604 |
| | | 9/12/2018 | 7.14 | 21 | 0.426 | 120 | 600 | -- | <0.0010 | 0.086 | -- | 8.5 | -- | 170 | <0.0040 | <0.00086 | <0.0010 | 0.018 | -- | **1.4** | 0.0057 | -- | 0.0702 | 0.0544 | 0.125 |
| | P-4 | 11/4/2016 | 7.1 | 20 | 0.34 | 81 | 530 | <0.0010 | <0.0010 | 0.144 | <0.0010 | 0.419 | <0.0010 | 131 | <0.0010 | <0.0050 | <0.0010 | 0.0379 | <0.00020 | 0.032 | 0.0022 | <0.0010 | 0.1 | 0.43 | 0.53 |
| | | 12/7/2016 | 7.42 | 21 | 0.48 | 91 | 452 | <0.0010 | <0.0010 | 0.109 | <0.0010 | 0.436 | <0.0010 | 96.9 | <0.0010 | <0.0050 | <0.0010 | 0.0251 | <0.00020 | 0.0318 | 0.001 | <0.0010 | 0.6 | 0.852 | 1.452 |
| | | 1/5/2017 | 7.58 | 28 | 0.568 | 94 | 390 | <0.0030 | <0.0010 | 0.12 | <0.0010 | 0.38 | <0.0010 | 87 | <0.0040 | <0.0020 | <0.0010 | 0.031 | <0.00020 | 0.033 | 0.0018 | <0.0010 | -0.211 | 0.885 | 0.885 |
| | | 1/28/2017 | 8 | 20 | 0.469 | 82 | 390 | <0.0030 | <0.0010 | 0.11 | <0.0010 | 0.39 | <0.0010 | 80 | <0.0040 | <0.0020 | <0.0010 | 0.029 | <0.00020 | 0.031 | <0.0010 | <0.0010 | 0.128 | 0.351 | 0.479 |
| | | 2/21/2017 | 7.29 | 20 | 0.362 | 86 | 480 | <0.0030 | <0.0010 | 0.13 | <0.0010 | 0.41 | <0.0010 | 110 | <0.0040 | <0.0020 | <0.0010 | **0.043** | <0.00020 | 0.029 | 0.0014 | <0.0010 | 0.0649 | 0.382 | 0.4469 |
| | | 3/30/2017 | 7.17 | 19 | 0.543 | 91 | 520 | <0.0030 | <0.0010 | 0.13 | <0.0010 | 0.4 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | **0.041** | <0.00020 | 0.029 | 0.0019 | <0.0010 | 0.107 | -0.3 | 0.107 |
| | | 4/26/2017 | 7.4 | 19 | 0.381 | 93 | 440 | <0.0030 | <0.0010 | 0.12 | <0.0010 | 0.45 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | 0.032 | <0.00020 | 0.03 | <0.0010 | <0.0010 | 0.107 | 0.651 | 0.758 |
| | | 5/17/2017 | 7.24 | 21 | <0.250 | 77 | 420 | <0.0030 | <0.0010 | 0.11 | <0.0010 | 0.42 | <0.0010 | 84 | <0.0040 | <0.0020 | <0.0010 | 0.038 | <0.00020 | 0.027 | <0.0010 | <0.0010 | 0.416 | 0.562 | 0.978 |
| | | 6/20/2017 | 7.28 | 20 | 0.38 | 89 | 490 | <0.0030 | <0.0010 | 0.12 | <0.0010 | 0.5 | <0.0010 | 100 | <0.0040 | <0.0020 | <0.0010 | **0.043** | <0.00020 | 0.026 | 0.0019 | <0.0010 | 0.327 | 0.764 | 1.091 |
| | | 8/16/2017 | 7.32 | 20 | <0.250 | 88 | 440 | <0.0030 | <0.0010 | 0.14 | <0.0010 | 0.48 | <0.0010 | 110 | <0.0040 | <0.0020 | <0.0010 | **0.05** | <0.00020 | 0.03 | 0.0024 | <0.0010 | 0.178 | 0.684 | 0.862 |
| | | 3/15/2018 | 7.33 | 20 | 0.324 | 78 | 420 | | | | | 0.45 | | 100 | | | | | | | | | | | |
| | | 5/29/2018 | | | | | | <0.0030 | <0.0010 | 0.11 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | 0.033 | 0.003 | <0.0010 | 0.13 | 0.464 | 0.594 |
| | | 9/12/2018 | 6.71 | 23 | 0.369 | 57 | 460 | -- | <0.0010 | 0.11 | -- | 0.43 | -- | 120 | <0.0040 | <0.00086 | <0.0010 | 0.028 | -- | 0.025 | 0.0022 | -- | 0.297 | -0.0493 | 0.297 |
| | P-5 | 11/3/2016 | 6.67 | 8 | 0.18 | 163 | 572 | <0.0010 | 0.0053 | 0.125 | <0.0010 | 7.98 | <0.0010 | 123 | <0.0010 | <0.0050 | <0.0010 | 0.0179 | <0.00020 | **0.235** | <0.0010 | <0.0010 | 0.51 | 1.49 | 2 |
| | | 12/6/2016 | 6.71 | 12 | 0.2 | 135 | 484 | <0.0010 | 0.0081 | 0.11 | <0.0010 | 6.22 | <0.0010 | 106 | <0.0010 | <0.0050 | <0.0010 | 0.0169 | <0.00020 | **0.235** | <0.0010 | <0.0010 | 0.536 | 0.879 | 1.415 |
| | | 1/4/2017 | 7.48 | 8.2 | <0.250 | 170 | 550 | <0.0030 | 0.0056 | 0.13 | <0.0010 | 8.2 | <0.0010 | 110 | <0.0040 | <0.0020 | <0.0010 | 0.025 | <0.00020 | **0.25** | <0.0010 | <0.0010 | 0.0669 | 1.58 | 1.6469 |
| | | 1/26/2017 | 7.73 | 5.4 | 0.364 | 210 | 630 | <0.0030 | 0.0068 | 0.14 | <0.0010 | 7 | <0.0010 | 110 | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | **0.23** | <0.0010 | <0.0010 | 0.0738 | 0.21 | 0.2838 |
| | | 2/22/2017 | 6.78 | 7.3 | <0.250 | 170 | 600 | <0.0030 | **0.011** | 0.15 | <0.0010 | 8.5 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | **0.27** | <0.0010 | <0.0010 | 0.374 | 0.852 | 1.226 |
| | | 3/30/2017 | 6.73 | 6.8 | 0.438 | 180 | 640 | <0.0030 | 0.0089 | 0.15 | <0.0010 | 7.5 | <0.0010 | 120 | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | **0.25** | <0.0010 | <0.0010 | 0.797 | 1.26 | 2.057 |
| | | 4/26/2017 | 6.88 | 6.2 | <0.250 | 210 | 680 | <0.0030 | 0.0099 | 0.17 | <0.0010 | 8.7 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.3** | <0.0010 | <0.0010 | 0.808 | 1.18 | 1.988 |
| | | 5/18/2017 | 6.8 | 6.7 | <0.250 | 230 | 720 | <0.0030 | 0.0069 | 0.18 | <0.0010 | 9.7 | <0.0010 | 140 | <0.0040 | <0.0020 | <0.0010 | 0.03 | <0.00020 | **0.36** | <0.0010 | <0.0010 | 0.555 | 0.745 | 1.3 |
| | | 6/20/2017 | 6.79 | 5.3 | 0.272 | 260 | 780 | <0.0030 | 0.0083 | 0.16 | <0.0010 | 11 | <0.0010 | 140 | <0.0040 | 0.002 | <0.0010 | 0.026 | <0.00020 | **0.26** | 0.0015 | <0.0010 | 0.95 | 1.21 | 2.16 |
| | | 8/16/2017 | 6.69 | 4.9 | <0.250 | 180 | 520 | <0.0030 | 0.0064 | 0.13 | <0.0010 | 9.1 | <0.0010 | 130 | <0.0040 | <0.0020 | <0.0010 | 0.024 | <0.00020 | **0.23** | <0.0010 | <0.0010 | 0.27 | 0.949 | 1.219 |
| | | 3/15/2018 | 6.94 | 5.4 | 0.266 | 180 | 650 | | | | | 8.2 | | 140 | | | | | | | | | | | |
| | | 5/29/2018 | | | | | | <0.0030 | 0.0066 | 0.17 | <0.0010 | | <0.0010 | | <0.0040 | <0.0020 | <0.0010 | 0.022 | <0.00020 | **0.28** | <0.0010 | <0.0010 | 1.02 | 0.213 | 1.233 |
| | | 9/11/2018 | 6.13 | 7 | <0.250 | 180 | 490 | -- | 0.0066 | 0.12 | -- | 9.2 | -- | 130 | <0.0040 | 0.0012 | <0.0010 | 0.012 | -- | **0.26** | <0.0010 | -- | 0.708 | 1.69 | 2.4 |

Notes:
Blank cells - Constituent not included in this analysis.
GW - Groundwater.
GWPS - Groundwater Protection Standard.
mg/L - milligrams per liter.

NA - Not Available.
NS - No Sample, sample was lost in transit.
pCi/L - picoCurie per liter.
su - standard units

Qualifiers:
< - Constituent was not detected, value is the reporting limit.

(a) - Site GWPS are the USEPA Maximum Contaminant Levels (MCLs), or where unavailable, the USEPA Tapwater Regional Screening Levels (RSLs).
USEPA 2018 Edition of the Drinking Water Standards and Health Advisories. Spring 2018.
http://water.epa.gov/drink/contaminants/index.cfm
USEPA Risk-Based Screening Levels (May 2019). Values for Tap Water. Hazard Index = 1.0.
https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

Detected Concentration > Groundwater Protection Standard. (shown in bold)

**TABLE 2**
**HUMAN HEALTH PUBLISHED SCREENING LEVELS FOR SURFACE WATER**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| | | Human Health Published Screening Level - Drinking Water | | | Human Health Published Screening Level - Surface Water | | Selected Published Human Health Screening Levels for Surface Water | |
|---|---|---|---|---|---|---|---|---|
| Constituent | CAS RN | Missouri Drinking Water Supply (a) (mg/L) | Missouri Groundwater (a) (mg/L) | May 2019 USEPA Tap Water RSLs (b) (mg/L) | Missouri Human Health Fish Consumption (a) (mg/L) | USEPA NRWQC Human Health Consumption of Organism Only (c) (mg/L) | Selected Screening Level - Drinking Water (d) (mg/L) | Selected Screening Level - Surface Water Consumption of Organism Only (e) (mg/L) |
| **Detection Monitoring - USEPA Appendix III Constituents (f)** | | | | | | | | |
| Boron | 7440-42-8 | NA | 2 | 4 | NA | NA | 2 | NA |
| Fluoride | 16984-48-8 | 4 | 4 | 0.8 | NA | NA | 4 | NA |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 0.006 | 0.0078 | 4.3 | 0.64 | 0.006 | 4.3 |
| Arsenic | 7440-38-2 | 0.05 | 0.05 | 0.000052 | NA | 0.00014 | 0.05 | 0.00014 |
| Barium | 7440-39-3 | 2 | 2 | 3.8 | NA | NA | 2 | NA |
| Beryllium | 7440-41-7 | 0.004 | 0.004 | 0.025 | NA | NA | 0.004 | NA |
| Cadmium | 7440-43-9 | 0.005 | 0.005 | 0.0092 | NA | NA | 0.005 | NA |
| Chromium | 7440-47-3 | 0.1 | 0.1 | 22 | NA | NA | 0.1 | NA |
| Cobalt | 7440-48-4 | NA | 1 | 0.006 | NA | NA | 1 | NA |
| Lead | 7439-92-1 | 0.015 | 0.015 | 0.015 | NA | NA | 0.015 | NA |
| Lithium | 7439-93-2 | NA | NA | 0.04 | NA | NA | 0.04 | NA |
| Mercury | 7439-97-6 | 0.002 | 0.002 | 0.0057 | NA | NA | 0.002 | NA |
| Molybdenum | 7439-98-7 | NA | NA | 0.1 | NA | NA | 0.1 | NA |
| Selenium | 7782-49-2 | 0.05 | 0.05 | 0.1 | NA | 4.2 | 0.05 | 4.2 |
| Thallium | 7440-28-0 | 0.002 | 0.002 | 0.0002 | 0.0063 | 0.00047 | 0.002 | 0.0063 |
| **Radiological (pCi/L)** | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 (g) | NA | NA | NA | NA | 5 | NA |

Notes:
CAS RN - Chemical Abstracts Service Registry Number.
mg/L - milligrams per liter.
NA - Not Available / Applicable.
NRWQC - National Recommended Water Quality Criteria.
pCi/L - picoCurie per liter.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - 10 Missouri Code of State Regulations Division 20 Chapter 7 Table A1. Updated January 29, 2019. http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf. Missouri State Drinking Water and Groundwater Standards apply to total results, Human Health Fish Consumption values apply to dissolved results (except mercury, which applies to total results);
(b) - USEPA Risk-Based Screening Levels (May 2019). Values for Tap Water. Hazard Index = 1.0. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables
(c) - USEPA National Recommended Water Quality Criteria - Human Health Criteria Table. USEPA Office of Water and Office of Science and Technology. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table
(d) - The hierarchy for selection among the Human Health Published Screening Levels for Drinking Water is:
1) Missouri Drinking Water Supply
2) Missouri Groundwater Supply
3) USEPA RSL - Tap Water
(e) - The hierarchy for selection among the Human Health Published Screening Values for Surface Water - Consumption of Organism Only is:
1) Missouri Human Health Fish Consumption
2) USEPA NRWQC - Consumption of Water and Organism.
(f) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.
(g) - USEPA Maximum Contaminant Level (MCL) used in the absence of a Missouri State value for radium in drinking water. USEPA, 2018. 2018 Edition of the Drinking Water Standards and Health Advisories. March. https://www.epa.gov/dwstandardsregulations/2018-drinking-water-standards-and-advisory-tables

**TABLE 3**
**HUMAN HEALTH CALCULATED RISK BASED SCREENING LEVELS FOR SURFACE WATER**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| | | Human Health Calculated RBSL - Recreational Use of Surface Water (c) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Constituent | CAS RN | Current/Future Off-Site Recreational Swimmer Age-Adjusted (Ages 1 - 26) (a) (mg/L) | | Current/Future Off-Site Recreational Wader Age-Adjusted (Ages 1 - 26) (a) (mg/L) | | Current/Future Off-Site Recreational Boater (Adult) (a) (mg/L) | | Selected Human Health Calculated RBSL - Recreational Use of Surface Water (b) (mg/L) |
| **Detection Monitoring - USEPA Appendix III Constituents (d)** | | | | | | | | |
| Boron | 7440-42-8 | 114 | | 120 | | 11,200 | | 114 |
| Fluoride | 16984-48-8 | 23.9 | | 22.9 | | 2,240 | | 22.9 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | |
| Antimony | 7440-36-0 | 0.171 | | 0.218 | | 3.36 | | 0.171 |
| Arsenic | 7440-38-2 | 0.0236 | (e, f) | 0.0389 | (e, g) | 2.61 | (e, h) | 0.0236 |
| Barium | 7440-39-3 | 63.7 | | 97.1 | | 784 | | 63.7 |
| Beryllium | 7440-41-7 | 0.121 | | 0.345 | | 0.784 | | 0.121 |
| Cadmium | 7440-43-9 | 0.134 | | 0.225 | | 1.4 | | 0.134 |
| Chromium (Total) | 7440-47-3 | 155 | (i) | 386 | (i) | 1090 | (i) | 155 |
| Cobalt | 7440-48-4 | 0.178 | | 0.181 | | 42 | | 0.178 |
| Lead | 7439-92-1 | 0.015 | (j) | 0.015 | (j) | 0.015 | (j) | 0.015 |
| Lithium | 7439-93-2 | 1.14 | | 1.2 | | 112 | | 1.14 |
| Mercury | 7439-97-6 | 0.0956 | (k) | 0.146 | (k) | 1.18 | (k) | 0.0956 |
| Molybdenum | 7439-98-7 | 2.86 | | 2.99 | | 280 | | 2.86 |
| Selenium | 7782-49-2 | 2.86 | | 2.99 | | 280 | | 2.86 |
| Thallium | 7440-28-0 | 0.00572 | | 0.00598 | | 0.56 | | 0.00572 |
| **Radiological (pCi/L)** | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | NA | | NA | | NA | | NA |

Notes:
CAS RN - Chemical Abstracts Service Registry Number.
NA - Not Available.
pCi/L - picoCuries/liter.
mg/L - milligrams/liter.
RBSL - Risk-Based Screening Level.
USEPA - United States Environmental Protection Agency.

(a) - Documentation for the receptor-specific Human Health Calculated Screening Level for Recreational Use of Surface Water is provided in Attachment B.
(b) - The selected human health RBSL for recreational use of surface water is the minimum value from amongst the Current/Future Off-Site Recreational Swimmer, Current/Future Off-Site Recreational Wader, and Current/Future Off-Site Recreational Boater RBSLs.
(c) - Some calculated values may be above solubility limits.
(d) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.
(e) - Arsenic RBSLs are based on the lower of the values based on a hazard index of 1 and an excess lifetime cancer risk of 1E-05.
Note that of the constituents evaluated, arsenic is the only constituent with an RSL based on potential carcinogenic effects.
(f) - RBSL based on cancer endpoint at 1E-5 (noncancer-based RBSL is 0.647 mg/L).
(g) - RBSL based on cancer endpoint at 1E-5 (noncancer-based RBSL is 3.04 mg/L).
(h) - RBSL based on cancer endpoint at 1E-5 (noncancer-based RBSL is 16.8 mg/L).
(i) - Value for chromium (III) used.
(j) - USEPA lead action level of 0.015 mg/L for lead in drinking water (USEPA, 2018) is used as the RBSL.
(k) - Value for mercuric chloride used.

**TABLE 4**
**ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| Constituent | CAS RN | Ecological Published Screening Levels - Surface Water: Missouri Protection of Aquatic Life Chronic (Dissolved) (a) (mg/L) | Missouri Protection of Aquatic Life Acute (Dissolved) (a) (mg/L) | USEPA NRWQC Aquatic Life Criteria CCC - Freshwater Chronic (Dissolved) (b) (mg/L) | USEPA NRWQC Aquatic Life Criteria CMC - Freshwater Acute (Dissolved) (b) (mg/L) | Selected Ecological Screening Level Acute (Dissolved) (c) (mg/L) | Selected Ecological Screening Level Chronic (Dissolved) (c) (mg/L) |
|---|---|---|---|---|---|---|---|
| **Detection Monitoring - USEPA Appendix III Constituents (e)** | | | | | | | |
| Boron | 7440-42-8 | NA | NA | NA | NA | NA | NA |
| Fluoride | 16984-48-8 | NA | NA | NA | NA | NA | NA |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | |
| Antimony | 7440-36-0 | NA | NA | NA | NA | NA | NA |
| Arsenic | 7440-38-2 | 0.15 | 0.34 | 0.15 | 0.34 | 0.34 | 0.15 |
| Barium | 7440-39-3 | NA | NA | NA | NA | NA | NA |
| Beryllium | 7440-41-7 | 0.005 | NA | NA | NA | NA | 0.005 |
| Cadmium | 7440-43-9 | 0.00072 (d) | 0.0018 (d) | 0.00072 (d) | 0.0018 (d) | 0.0018 | 0.0007 |
| Chromium | 7440-47-3 | 0.074 (d, e) | 0.57 (d, e) | 0.074 (d, e) | 0.57 (d, e) | 0.57 | 0.07 |
| Cobalt | 7440-48-4 | NA | NA | NA | NA | NA | NA |
| Lead | 7439-92-1 | 0.0025 (d) | 0.065 (d) | 0.0025 (d) | 0.065 (d) | 0.065 | 0.0025 |
| Lithium | 7439-93-2 | NA | NA | NA | NA | NA | NA |
| Mercury | 7439-97-6 | 0.00077 | 0.0014 | 0.00077 | 0.0014 | 0.0014 | 0.00077 |
| Molybdenum | 7439-98-7 | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 0.005 | NA | 0.0031 (f) | NA | NA | 0.005 |
| Thallium | 7440-28-0 | NA | NA | NA | NA | NA | NA |
| **Radiological (pCi/L)** | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | NA | NA | NA | NA | NA | NA |

Notes:
CAS RN - Chemical Abstracts Service Registry Number.
mg/L - milligrams per liter.
NA - Not Available / Applicable.
pCi/L - picoCurie per liter.
NRWQC - National Recommended Water Quality Criteria
CCC - Continuous Criterion Concentration
CMC - Criterion Maximum Concentration
USEPA - United States Environmental Protection Agency

(a) - 10 Missouri Code of State Regulations Division 20 Chapter 7 Table A1. Updated January 29, 2019. http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf. Missouri State Protection of Aquatic Life Chronic values apply to dissolved results (except mercury, which applies to total results).
(b) - USEPA Water Quality Criteria. Current Water Quality Criteria Tables. National Recommended Water Quality Criteria - Aquatic Life Criteria Table. http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
(c) - The hierarchy for the selection of ecological screening levels is:
1) Missouri Protection of Aquatic Life Criteria.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.
(d) - Hardness dependent value for total metals adjusted for dissolved fraction. Default mean hardness value of 100 mg/L as CaCO3 used.
(e) - Value for trivalent chromium used.
(f) - USEPA Office of Water. Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenium - Freshwater. 30 June 2016. Freshwater value for chronic (30 day) water column concentration (mg/L) of dissolved selenium in lotic (flowing) surface water. The criterion is based on fish ovary concentrations, and in lieu of that, the water column values are used. https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf

**TABLE 5**
**SELECTED SURFACE WATER SCREENING LEVELS**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| Constituent | CAS RN | HH DW SL (a) (mg/L) | HH REC SL - Consumption of Organism Only (b) (mf/L) | HH Recreational Calculated RBSL (c) (mg/L) | ECO SL - Dissolved (acute) (d) (mg/L) | ECO SL - Dissolved (chronic) (d) (mg/L) |
|---|---|---|---|---|---|---|
| **Detection Monitoring - USEPA Appendix III Constituents (e)** | | | | | | |
| Boron | 7440-42-8 | 2 | NA | 114 | NA | NA |
| Fluoride | 16984-48-8 | 4 | NA | 22.9 | NA | NA |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 4.3 | 0.171 | NA | NA |
| Arsenic | 7440-38-2 | 0.05 | 0.00014 | 0.236 | 0.34 | 0.15 |
| Barium | 7440-39-3 | 2 | NA | 63.7 | NA | NA |
| Beryllium | 7440-41-7 | 0.004 | NA | 0.121 | NA | 0.005 |
| Cadmium | 7440-43-9 | 0.005 | NA | 0.134 | 0.0018 | 0.0007 |
| Chromium (Total) | 7440-47-3 | 0.1 | NA | 155 | 0.57 | 0.07 |
| Cobalt | 7440-48-4 | 1 | NA | 0.178 | NA | NA |
| Lead | 7439-92-1 | 0.015 | NA | 0.015 | 0.065 | 0.0025 |
| Lithium | 7439-93-2 | 0.04 | NA | 1.14 | NA | NA |
| Mercury | 7439-97-6 | 0.002 | NA | 0.0956 | 0.0014 | 0.00077 |
| Molybdenum | 7439-98-7 | 0.1 | NA | 2.86 | NA | NA |
| Selenium | 7782-49-2 | 0.05 | 4.2 | 2.86 | NA | 0.005 |
| Thallium | 7440-28-0 | 0.002 | 0.0063 | 0.00572 | NA | NA |
| **Radiological (pCi/L)** | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 | NA | NA | NA | NA |

Notes:
CAS RN - Chemical Abstracts Service Registry Number.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.
RBSL - Risk-Based Screening Level.

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
1) Missouri Drinking Water Supply
2) Missouri Groundwater Supply
3) USEPA RSL - Tap Water

(b) - Human Health Surface Water Screening Levels selected in Table 2 using the following hierarchy:
1) Missouri Human Health Fish Consumption
2) USEPA NRWQC - Consumption of Water and Organism.

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:
1) Missouri Protection of Aquatic Life Criteria.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.

(e) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

**TABLE 6**
**DERIVATION OF RISK-BASED TARGET SCREENING LEVELS FOR GROUNDWATER**
**AECI NEW MADRID POWER PLANT - POND 003 COMPLEX**
**NEW MADRID, MISSOURI**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Dilution Attenuation Factor (e)** | **100,000** | | | |
| **Constituent** | **CAS RN** | **HH DW SL (a) (mg/L)** | **HH REC SL - Consumption of Organism Only (b) (mg/L)** | **HH Recreational Calculated RBSL (c) (mg/L)** | **ECO SL - Dissolved (acute) (d) (mg/L)** | **ECO SL - Dissolved (chronic) (d) (mg/L)** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Target Groundwater Screening Level - Mississippi River (f) (mg/L)** | **Maximum Groundwater Concentration (mg/L)** | | **Ratio Between Target Groundwater Screening Level and the Maximum Groundwater Concentration** |
| **Detection Monitoring - USEPA Appendix III Constituents (g)** | | | | | | | | | | | |
| Boron | 7440-42-8 | 2 | NA | 114 | NA | NA | 2 | 200,000 | 20 | MW-7 | 10,000 |
| Fluoride | 16984-48-8 | 4 | NA | 22.9 | NA | NA | 4 | 400,000 | 0.679 | P-2 | >580,000 |
| **Assessment Monitoring - USEPA Appendix IV Constituents** | | | | | | | | | | | |
| Antimony | 7440-36-0 | 0.006 | 4.3 | 0.171 | NA | NA | 0.006 | 600 | 0.0031 | P-1 | >190,000 |
| Arsenic | 7440-38-2 | 0.05 | 0.00014 | 0.0236 | 0.34 | 0.15 | 0.00014 | 14 | 0.011 | P-5 | >1,000 |
| Barium | 7440-39-3 | 2 | NA | 63.7 | NA | NA | 2 | 200,000 | 0.181 | MW-7 | >1,000,000 |
| Beryllium | 7440-41-7 | 0.004 | NA | 0.121 | NA | 0.005 | 0.004 | 400 | 0.001 U | | NA |
| Cadmium | 7440-43-9 | 0.005 | NA | 0.134 | 0.0018 | 0.0007 | 0.0007 | 72 | 0.0016 | MW-7 | >44,000 |
| Chromium (Total) | 7440-47-3 | 0.1 | NA | 155 | 0.57 | 0.07 | 0.07 | 7,411 | 0.018 | P-1 | >410,000 |
| Cobalt | 7440-48-4 | 1 | NA | 0.178 | NA | NA | 0.178 | 17,800 | 0.0098 | MW-7 | >1,000,000 |
| Lead | 7439-92-1 | 0.015 | NA | 0.015 | 0.065 | 0.0025 | 0.0025 | 252 | 0.0047 | P-3 | >53,000 |
| Lithium | 7439-93-2 | 0.04 | NA | 1.14 | NA | NA | 0.04 | 4,000 | 0.05 | P-4 | 80,000 |
| Mercury | 7439-97-6 | 0.002 | NA | 0.0956 | 0.0014 | 0.00077 | 0.00077 | 77 | <0.00020 | | NA |
| Molybdenum | 7439-98-7 | 0.1 | NA | 2.86 | NA | NA | 0.1 | 10,000 | 3.9 | MW-7 | >2,500 |
| Selenium | 7782-49-2 | 0.05 | 4.2 | 2.86 | NA | 0.005 | 0.005 | 500 | 0.008 | P-3 | >62,000 |
| Thallium | 7440-28-0 | 0.002 | 0.0063 | 0.00572 | NA | NA | 0.002 | 200 | 0.002 | MW-7 | 100,000 |
| **Radiological (pCi/L)** | | | | | | | | | | | |
| Radium-226 & 228 | 7440-14-4 | 5 | NA | NA | NA | NA | 5 | 500,000 | 3.8 | MW-7 | >130,000 |

Notes:

CAS RN - Chemical Abstracts Service Registry Number.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.

(a) - Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
1) Missouri Drinking Water Supply
2) Missouri Groundwater Supply
3) USEPA RSL - Tap Water

(b) - Surface Water Screening Levels selected in Table 2 using the following hierarchy:
1) Missouri Human Health Fish Consumption
2) USEPA NRWQC - Consumption of Water and Organism.

(c) - The Human Health Calculated Screening Levels are presented in Table 3.
The minimum calculated value for the Off-Site Recreational Boater, Wader, and Swimmer was selected.

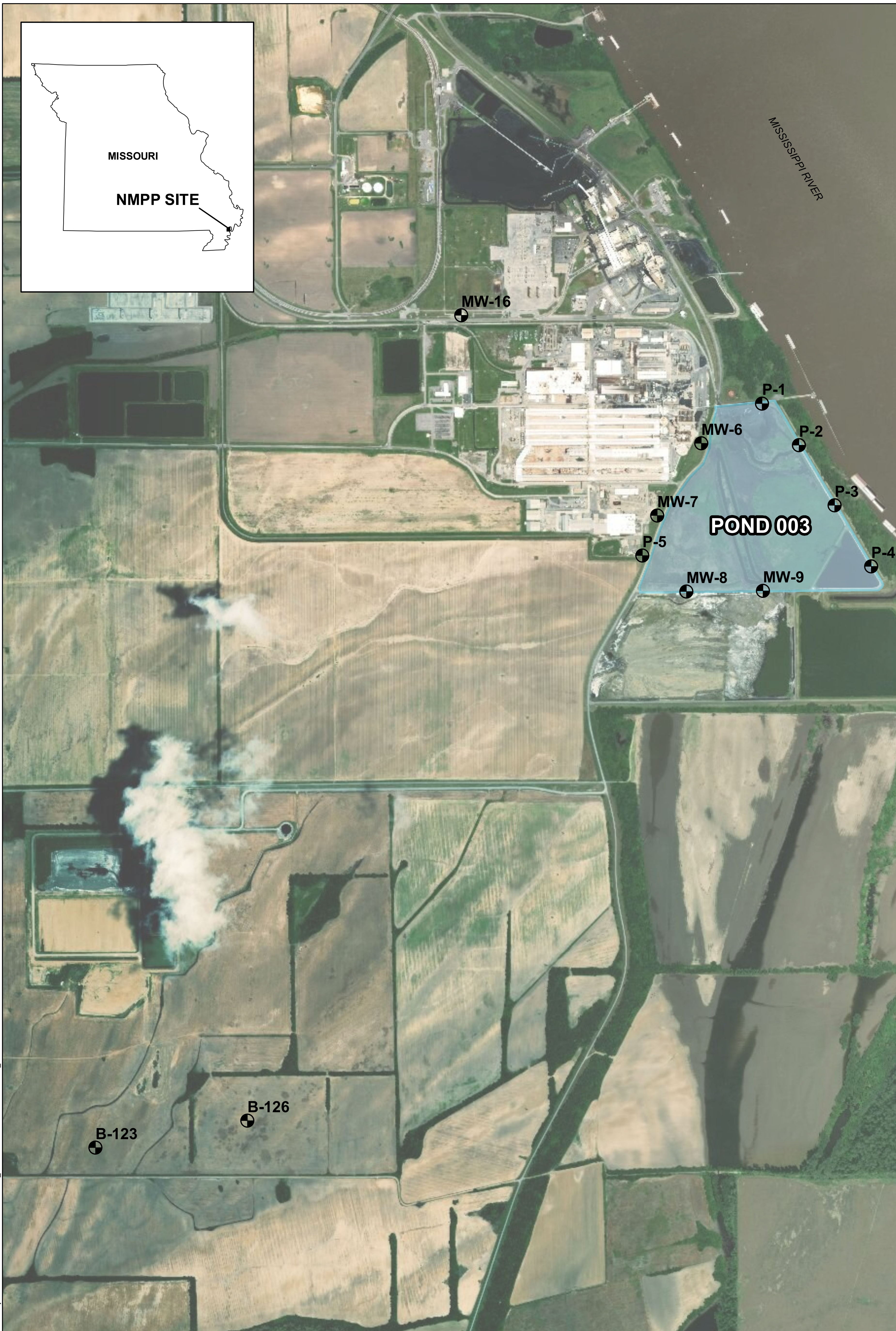
(d) - Ecological Screening Levels selected in Table 4 using the following hierarchy:
1) Missouri Protection of Aquatic Life Criteria.
2) USEPA NRWQC. Aquatic Life Criteria - Freshwater.

(e) - Estimated value, see text for derivation.

(f) - The Target Groundwater Screening Level = Minimum SL x Dilution Factor.

(g) - Detection Monitoring - EPA Appendix III Constituents without health risk-based screening levels are not included.

# FIGURES




**LEGEND**

MONITORING WELL

POND 003

N

0 1,500 3,000
SCALE IN FEET

**NOTE**
1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI, 19 MAY 2016.

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER PLANT
MARSTON, MISSOURI

POND 003 MONITORING WELL LOCATION MAP

aeci

JANUARY 2019
SCALE: AS SHOWN

FIGURE 1


**LEGEND**

MONITORING WELL

POND 003

GROUNDWATER FLOW DIRECTION

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI, 19 MAY 2016.

N

0 330 660

SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER GENERATING FACILITY
NEW MADRID COUNTY, MISSOURI

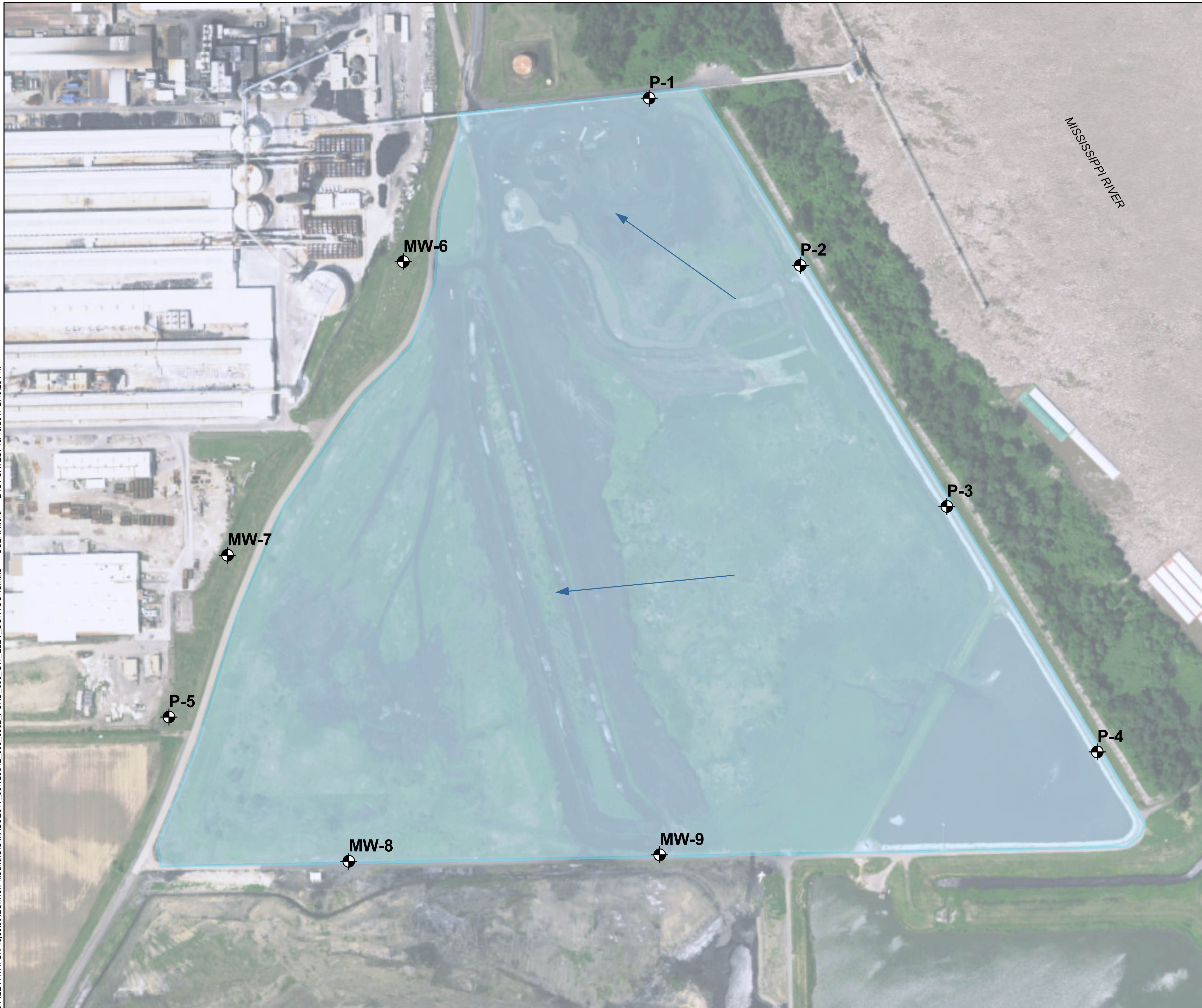
POND 003 - GROUNDWATER
FLOW DIRECTION MAP
LOW RIVER STAGE
3/28/2017

aeci

OCTOBER 2017

FIGURE 2

GIS FILE PATH: G:\Projects\AECI\New Madrid\GIS\MXDs\2017_09\129342_003_0002_POND_003_GW_ELEV_CONTOURS_LOW.mxd — USER: kford — LAST SAVED: 10/16/2017 2:37:59 PM




LEGEND

MONITORING WELL

POND 003

GROUNDWATER FLOW DIRECTION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. AERIAL IMAGERY SOURCE: ESRI, 19 MAY 2016.

0 330 660

SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER GENERATING FACILITY
NEW MADRID COUNTY, MISSOURI

POND 003 - GROUNDWATER FLOW DIRECTION MAP HIGH RIVER STAGE 5/17/2017

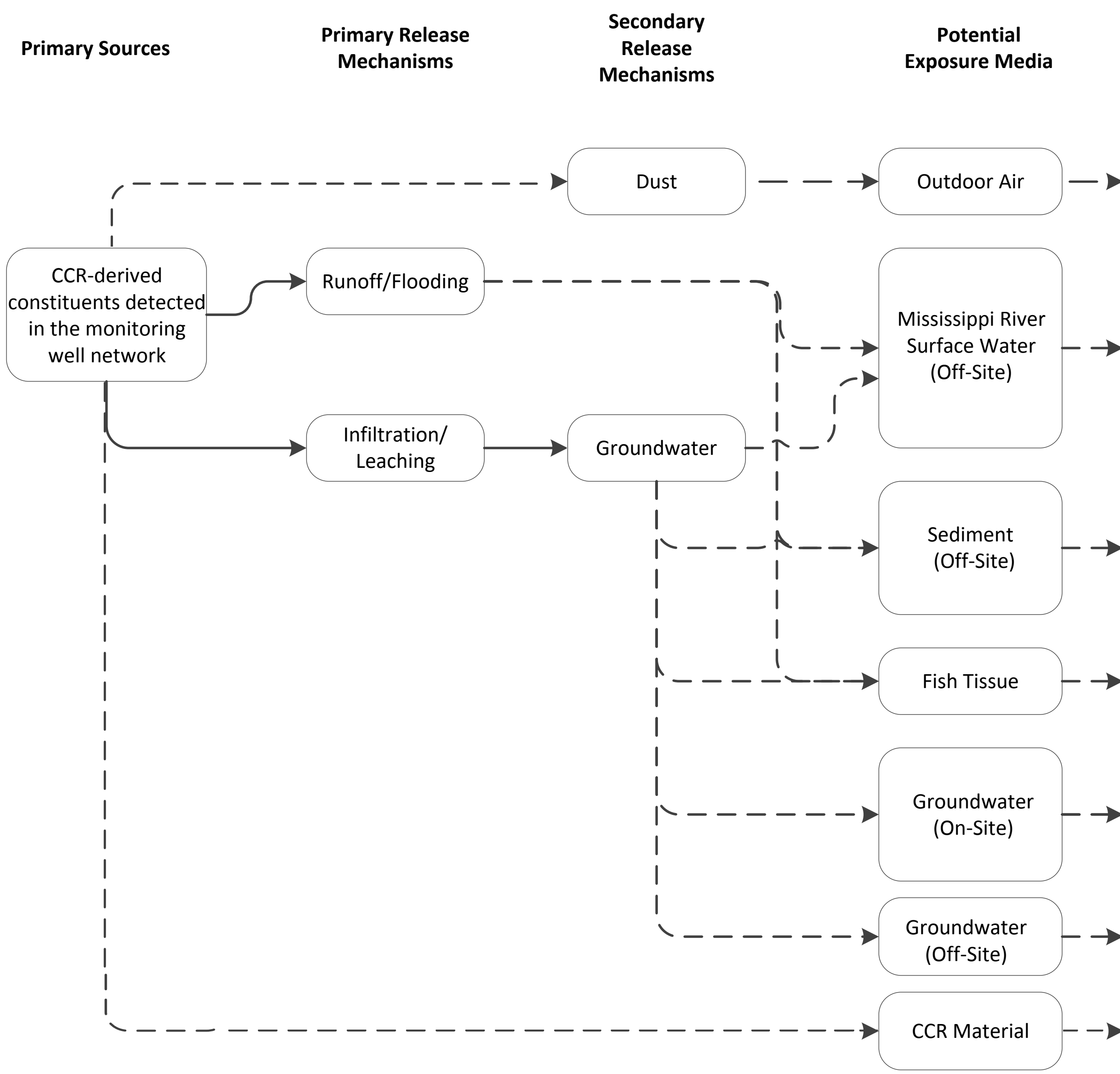
aeci

OCTOBER 2017

FIGURE 3

GIS FILE PATH: G:\Projects\AECI\New Madrid\GIS\MXDs\2017_09\129342_003_0002_POND_003_GW_ELEV_CONTOURS.mxd — USER: kford — LAST SAVED: 10/16/2017 2:40:28 PM

**FIGURE 4**
**CONCEPTUAL SITE MODEL**
**ASSOCIATED ELECTRIC COOPERATIVE, INC.**
**NEW MADRID POWER GENERATING FACILITY**
**NEW MADRID COUNTY, MISSOURI**




| Potential Exposure Media | Potential Exposure Route | Current/Future Commercial/ Industrial Worker | Current/Future On-Site Construction Worker | Current/Future On-Site Trespasser | Current/Future Off-Site Resident Adult/Child | Current/Future Off-Site Recreational User (a) | Benthic Invertebrates and Fish | Aquatic Birds and Mammals | Terrestrial Birds and Mammals |
|---|---|---|---|---|---|---|---|---|---|
| | | **Potential Receptors** | | | | | | | |
| Outdoor Air | Inhalation | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Mississippi River Surface Water (Off-Site) | Drinking Water Use | ○ | ○ | ○ | ● | ○ | ○ | ○ | ○ |
| | Plant/Incidental Ingestion | ○ | ○ | ○ | ● | ● | ● | ● | ○ |
| | Direct Contact | ○ | ○ | ○ | ● | ● | ○ | ○ | ○ |
| Sediment (Off-Site) | Plant/Incidental Ingestion | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Direct Contact | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Fish Tissue | Ingestion | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ |
| Groundwater (On-Site) | Incidental Ingestion | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Direct Contact | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Groundwater (Off-Site) | Drinking Water Use | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| CCR Material | Direct Contact | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

(a) Includes Current/Future Off-Site Recreational Wader, Recreational Swimmer, Recreational Boater, and Recreational Fisher.

● Pathway potentially complete and evaluated in this assessment to determine if pathway would be associated with a significant risk to human health or the environment.

○ Pathway determined to be incomplete or insignificant and therefore not further evaluated in this assessment.

——► Potential complete migration pathway.
— —► Incomplete/insignificant migration pathway.
CCR: Coal Combustion Residuals.


**LEGEND**

- MONITORING WELL
- POINT OF COMPLIANCE (POC)
- POINT OF EXPOSURE (POE)
- DISCHARGE DIRECTION
- POND 003

$$\text{CONCENTRATION AT POE} = \frac{\text{POC CONCENTRATION}}{Q_{RIVER} / Q_{GROUNDWATER}}$$

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 330 660

SCALE IN FEET

HALEY ALDRICH

ASSOCIATED ELECTRIC COOPERATIVE, INC.
NEW MADRID POWER GENERATING FACILITY
NEW MADRID COUNTY, MISSOURI

POND 003 - DAF CALCULATION
LOW RIVER STAGE
3/28/2017

aeci

MARCH 2019

FIGURE 7

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AECI\New Madrid\GIS\MXDs\2019_03\129342_016_0007_POND_003_DAF_CALCULATION_LOW.mxd — USER: anichols — LAST SAVED: 3/4/2019 3:09:49 PM

# ATTACHMENT A

## Calculated Recreator Risk-Based Screening Levels

**TABLE A-1**
**HUMAN HEALTH EXPOSURE PARAMETERS FOR DERIVATION OF RISK BASED SCREENING LEVELS (RBSLs) - RECREATIONAL SURFACE WATER**

| Exposure Parameter | | Units | Current/Future Off-Site Recreational Swimmer | | | | | | | | Current/Future Off-Site Recreational Wader | | | | | | | | Current/Future Off-Site Recreational Boater | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Child (Age <6 ) | | Adolescent (6-<16 years) | | Adult | | Child, Adolescent and Adult (Ages 1 - 26) | | Child (Age <6 ) | | Adolescent (6-<16 years) | | Adult | | Child, Adolescent and Adult (Ages 1 - 26) | | Adult | |
| **Standard Parameters** | | | | | | | | | | | | | | | | | | | | |
| Body Weight | BW | kg | 15 | USEPA, 2011 [1] | 44 | USEPA, 2011 [1] | 80 | USEPA, 2014a | NA | | 15 | USEPA, 2011 [1] | 44 | USEPA, 2011 [1] | 80 | USEPA, 2014a | NA | | 80 | USEPA, 2014a |
| Exposure Duration | ED | years | 6 | Ages <6 | 10 | Ages 6 - <16 | 10 | Balance of 26-yr exposure | 26 | | 6 | Ages <6 | 10 | Ages 6 - <16 | 10 | Balance of 26-yr exposure | 26 | | 10 | Balance of 26-yr exposure |
| Non–carcinogenic Averaging Time | Atnc | days | 2190 | ED expressed in days | 3650 | ED expressed in days | 3650 | ED expressed in days | 9490 | ED expressed in days | 2190 | ED expressed in days | 3650 | ED expressed in days | 3650 | ED expressed in days | 9490 | ED expressed in days | 3650 | ED expressed in days |
| Carcinogenic Averaging Time | Atc | days | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime | 25550 | 70 year lifetime |
| **Incidental Ingestion of Surface Water** | | | | | | | | | | | | | | | | | | | | |
| Exposure Frequency | EF | days/year | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | NA | |
| Water Ingestion Rate | IR | L/day | 0.10 | USEPA, 2014b [2] | 0.10 | USEPA, 2014b [2] | 0.10 | USEPA, 2014b [2] | NA | | 0.10 | USEPA, 2014b [2] | 0.02 | USEPA, 2014b [2] | 0.02 | USEPA, 2014b [2] | NA | | NA | |
| Fraction Ingested | FI | unitless | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | 1.0 | Assumption | NA | |
| Age-Adjusted Water Ingestion Factor | IFWadj | L/kg | NA | | NA | | NA | | 3.39 | | NA | | NA | | NA | | 2.12 | | NA | |
| Age-Adjusted Water Ingestion Factor-Mutagenic | IFWM | L/kg | NA | | NA | | NA | | 13.23 | | NA | | NA | | NA | | 10.33 | | NA | |
| **Dermal Exposure with Surface Water** | | | | | | | | | | | | | | | | | | | | |
| Exposure Frequency | EF | days/year | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b | 45 | USEPA, 2014b |
| Exposed Skin Surface Area | SA | $cm^2$ | 6365 | USEPA, 2014a | 13350 | USEPA, 2011 [3] | 19652 | USEPA, 2014a | NA | | 1770 | USEPA, 2011 [4] | 3820 | USEPA, 2011 [4] | 5790 | USEPA, 2011 [4] | NA | | 5790 | USEPA, 2011 [4] |
| Exposure Time | t-event | hr/event | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific [5] | 2 | Site-specific | 2 | Site-specific [5] |
| Events per Day | EV | event/day | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific [5] | 1.0 | Site-specific | 1 | Site-specific [5] |
| Age-Adjusted Dermal Contact Factor | DFWadj | events-$cm^2$/kg | NA | | NA | | NA | | 361647 | | NA | | NA | | NA | | 103497 | | NA | |
| Age-Adjusted Dermal Contact Factor-Mutagenic | DFWM | events-$cm^2$/kg | NA | | NA | | NA | | 1131185 | | NA | | NA | | NA | | 319693 | | NA | |

**NOTES AND ABBREVIATIONS**

USEPA, 2002 - Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OWSWER 9355.4-24
USEPA, 2011 - Exposure Factors Handbook. USEPA/600/R-10/030. October, 2011.
USEPA, 2014a - Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER 9200.1-120. February 6, 201.
USEPA, 2014b - Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014. Draft Final.
[1] - Table 8-1 of USEPA (2011).
[2] - Ingestion rate of 50 ml/hour of surface water is used for exposures to water during swimming. Intake rates for exposure to surface water during wading are 50 ml/hour for children 1-6, and 10 ml/hour for adolescents and adults.
The water ingestion rate in liters/day is calculated as follows: ingestion (ml/hr) x exposure time (hr/event)/1000 (ml/L).
[3] - Based on weighted average of mean values for 6-<16 years.
[4] - Based on surface area of hands, forearms, lower legs, and feet.
[5] - Assumes 2 hours per event and that on days when recreation in water occurs, all daily exposure to water is derived from locations at the Site.

Values based on a time-weighted average of child, adolescent, and adult exposure values are calculated as follows:
Water
IFWadj = (child ED [0-2] x child EF [0-2] x child IR [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] / child BW [2-6]) + (older child ED [6-16] x older child EF [6-16] x older child IR [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR / adult BW)
DFWadj = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV / adult BW)
Water - mutagenic
IFWM = (child ED [0-2] x child EF [0-2] x child IR [0-2] x ADAF [0-2] / child BW [0-2]) + (child ED [2-6] x child EF [2-6] x child IR [2-6] x ADAF [2-6] / child BW [2-6]) + (older child ED [6-16] x child EF [6-16] x older child IR [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult ED x adult EF x adult IR x adult ADAF / adult BW)
DFWM = (child EF [0-2] x child ED [0-2] x child SA [0-2] x child EV [0-2] x ADAF [0-2] / child BW [0-2]) + (child EF [2-6] x child ED [2-6] x child SA [2-6] x child EV [2-6] x ADAF [2-6] / child BW [2-6]) + (older child EF [6-16] x older child ED [6-16] x older child SA [6-16] x older child EV [6-16] x ADAF [6-16] / older child BW [6-16]) + (adult EF x adult ED x adult SA x adult EV x adult ADAF / adult BW)

USEPA guidance for early life exposure to carcinogens (USEPA, 2005) requires that risks for potentially carcinogenic constituents that are presumed to act by a mutagenic mode of action be calculated differently than for constituents that do not act via a mutagenic mode of action.
Therefore, the age-dependent adjustment factors (ADAF) will be applied for calculations involving children under the age of 16. The ADAFs are as follows:

Age 0 to 2 years (2 year interval from birth until 2nd birthday) – ADAF = 10
Ages 2 to 16 years (14 year interval from 2nd birthday to 16th birthday) – ADAF = 3
Ages 16 and up (after 16th birthday) – no adjustment - ADAF = 1

The exposure parameters for children ages <6 are applied to children 0 - 2 and 2- 6.

# Site-specific

## Recreator Equation Inputs for Surface Water

### * Inputted values different from Recreator defaults are highlighted.

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (body weight) kg | 15 | 0 |
| $BW_{2-6}$ (body weight) kg | 15 | 0 |
| $BW_{6-16}$ (body weight) kg | 80 | 0 |
| $BW_{16-30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 80 |
| $BW_{rec-a}$ (body weight - adult) kg | 80 | 80 |
| $DFW_{rec-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 0 | 32568.75 |
| $DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 0 | 32568.75 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 10 |
| $ED_{0-2}$ (exposure duration) years | 2 | 0 |
| $ED_{2-6}$ (exposure duration) years | 4 | 0 |
| $ED_{6-16}$ (exposure duration) years | 10 | 0 |
| $ED_{16-30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec-a}$ (exposure duration - adult) years | 20 | 10 |
| $EF_{rec-w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{0-2}$ (exposure frequency) days/year | 0 | 0 |
| $EF_{2-6}$ (exposure frequency) days/year | 0 | 0 |
| $EF_{6-16}$ (exposure frequency) days/year | 0 | 0 |
| $EF_{16-30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec-a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0-2}$ (exposure time) hours/event | 0 | 0 |
| $ET_{2-6}$ (exposure time) hours/event | 0 | 0 |
| $ET_{6-16}$ (exposure time) hours/event | 0 | 0 |
| $ET_{16-30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec-a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0-2}$ (events) events/day | 0 | 0 |
| $EV_{2-6}$ (events) events/day | 0 | 0 |
| $EV_{6-16}$ (events) events/day | 0 | 0 |
| $EV_{16-30}$ (events) events/day | 0 | 1 |
| $EV_{rec-a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg | 0 | 0 |
| $IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 0 |
| $IRW_{0-2}$ (water intake rate) L/hour | 0.12 | 0 |
| $IRW_{2-6}$ (water intake rate) L/hour | 0.12 | 0 |
| $IRW_{6-16}$ (water intake rate) L/hour | 0.071 | 0 |
| $IRW_{16-30}$ (water intake rate) L/hour | 0.071 | 0 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.071 | 0 |
| $IRW_{rec-a}$ (water intake rate - adult) L/hr | 0.071 | 0 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0-2}$ (skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{2-6}$ (skin surface area) $cm^2$ | 6365 | 0 |
| $SA_{6-16}$ (skin surface area) $cm^2$ | 19652 | 0 |
| $SA_{16-30}$ (skin surface area) $cm^2$ | 19652 | 5790 |
| $SA_{rec}$ (skin surface area - adult) $cm^2$ | 19652 | 5790 |
| $SA_{rec-a}$ (skin surface area - adult) $cm^2$ | 19652 | 5790 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.00001 |

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## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$ (mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? | $DA_{event(ca)}$ | $DA_{event(nc\ child)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=1E-05 (ug/L) | Dermal SL TR=1E-05 (ug/L) | Carcinogenic SL TR=1E-05 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | - | | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes | - | - | 0.0067 | - | - | - | - | - | - | - | 3360.0000 | 3360.0000 | 3.36E+03nc |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes | 0.0005 | - | 0.0336 | - | 2610.0000 | 2610.0000 | - | - | - | - | 16800.0000 | 16800.0000 | 2.61E+03ca* |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes | - | - | 1.5690 | - | - | - | - | - | - | - | 784000.0000 | 784000.0000 | 7.84E+05nc |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes | - | - | 0.0016 | - | - | - | - | - | - | - | 784.0000 | 784.0000 | 7.84E+02nc |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes | - | - | 22.4141 | - | - | - | - | - | - | - | 11200000.0000 | 11200000.0000 | 1.12E+07nc |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes | - | - | 0.0028 | - | - | - | - | - | - | - | 1400.0000 | 1400.0000 | 1.40E+03nc |
| Chromium(III), Insoluble Salts | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes | - | - | 2.1854 | - | - | - | - | - | - | - | 1090000.0000 | 1090000.0000 | 1.09E+06nc |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes | - | - | 0.0336 | - | - | - | - | - | - | - | 42000.0000 | 42000.0000 | 4.20E+04nc |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes | - | - | 4.4828 | - | - | - | - | - | - | - | 2240000.0000 | 2240000.0000 | 2.24E+06nc |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes | - | - | 0.2241 | - | - | - | - | - | - | - | 112000.0000 | 112000.0000 | 1.12E+05nc |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | S | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes | - | - | 0.0024 | - | - | - | - | - | - | - | 1180.0000 | 1180.0000 | 1.18E+03nc |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes | - | - | 0.5604 | - | - | - | - | - | - | - | 280000.0000 | 280000.0000 | 2.80E+05nc |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes | - | - | 0.5604 | - | - | - | - | - | - | - | 280000.0000 | 280000.0000 | 2.80E+05nc |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes | - | - | 0.0011 | - | - | - | - | - | - | - | 560.0000 | 560.0000 | 5.60E+02nc |

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# Site-specific

## Recreator Equation Inputs for Surface Water

### * Inputted values different from Recreator defaults are highlighted.

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (body weight) kg | 15 | 15 |
| $BW_{2-6}$ (body weight) kg | 15 | 15 |
| $BW_{6-16}$ (body weight) kg | 80 | 44 |
| $BW_{16-30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 62 |
| $BW_{rec-a}$ (body weight - adult) kg | 80 | 62 |
| $DFW_{rec-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 0 | 354100.645 |
| $DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 0 | 1131184.77 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 26 |
| $ED_{0-2}$ (exposure duration) years | 2 | 2 |
| $ED_{2-6}$ (exposure duration) years | 4 | 4 |
| $ED_{6-16}$ (exposure duration) years | 10 | 10 |
| $ED_{16-30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec-a}$ (exposure duration - adult) years | 20 | 20 |
| $EF_{rec-w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{0-2}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{2-6}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{6-16}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{16-30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec-a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0-2}$ (exposure time) hours/event | 0 | 2 |
| $ET_{2-6}$ (exposure time) hours/event | 0 | 2 |
| $ET_{6-16}$ (exposure time) hours/event | 0 | 2 |
| $ET_{16-30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec-a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0-2}$ (events) events/day | 0 | 1 |
| $EV_{2-6}$ (events) events/day | 0 | 1 |
| $EV_{6-16}$ (events) events/day | 0 | 1 |
| $EV_{16-30}$ (events) events/day | 0 | 1 |
| $EV_{rec-a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg | 0 | 6.503 |
| $IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 26.461 |
| $IRW_{0-2}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{2-6}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{6-16}$ (water intake rate) L/hour | 0.071 | 0.1 |
| $IRW_{16-30}$ (water intake rate) L/hour | 0.071 | 0.1 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.071 | 0.1 |
| $IRW_{rec-a}$ (water intake rate - adult) L/hr | 0.071 | 0.1 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0-2}$ (skin surface area) $cm^2$ | 6365 | 6365 |
| $SA_{2-6}$ (skin surface area) $cm^2$ | 6365 | 6365 |
| $SA_{6-16}$ (skin surface area) $cm^2$ | 19652 | 13350 |
| $SA_{16-30}$ (skin surface area) $cm^2$ | 19652 | 19652 |
| $SA_{rec}$ (skin surface area - adult) $cm^2$ | 19652 | 16501 |
| $SA_{rec-a}$ (skin surface area - adult) $cm^2$ | 19652 | 16501 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.00001 |

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## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$(mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC ($mg/m^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? | $DA_{event(ca)}$ | $DA_{event(nc\ child)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=1E-05 (ug/L) | Dermal SL TR=1E-05 (ug/L) | Carcinogenic SL TR=1E-05 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | - | | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes | - | 0.0011 | 0.0018 | - | - | - | 243.0000 | 573.0000 | 171.0000 | 1010.0000 | 914.0000 | 479.0000 | 1.71E+02nc |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes | 0.0000 | 0.0057 | 0.0091 | 26.2000 | 241.0000 | 23.6000 | 183.0000 | 2870.0000 | 172.0000 | 754.0000 | 4570.0000 | 647.0000 | 2.36E+01ca* |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes | - | 0.2676 | 0.4267 | - | - | - | 122000.0000 | ########## | 63700.0000 | 503000.0000 | ########## | 150000.0000 | 6.37E+04nc |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes | - | 0.0003 | 0.0004 | - | - | - | 1220.0000 | 134.0000 | 121.0000 | 5030.0000 | 213.0000 | 205.0000 | 1.21E+02nc |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes | - | 3.8230 | 6.0953 | - | - | - | 122000.0000 | ########## | 114000.0000 | 503000.0000 | ########## | 432000.0000 | 1.14E+05nc |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes | - | 0.0005 | 0.0008 | - | - | - | 304.0000 | 239.0000 | 134.0000 | 1260.0000 | 381.0000 | 292.0000 | 1.34E+02nc |
| Chromium(III), Insoluble Salt | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes | - | 0.3727 | 0.5943 | - | - | - | 913000.0000 | ########## | 155000.0000 | ########### | ########## | 275000.0000 | 1.55E+05nc |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes | - | 0.0057 | 0.0091 | - | - | - | 183.0000 | 7170.0000 | 178.0000 | 754.0000 | 11400.0000 | 708.0000 | 1.78E+02nc |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes | - | 0.7646 | 1.2191 | - | - | - | 24300.0000 | ########## | 22900.0000 | 101000.0000 | ########## | 86300.0000 | 2.29E+04nc |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes | - | 0.0382 | 0.0610 | - | - | - | 1220.0000 | 19100.0000 | 1140.0000 | 5030.0000 | 30500.0000 | 4320.0000 | 1.14E+03nc |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | S | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes | - | 0.0004 | 0.0006 | - | - | - | 183.0000 | 201.0000 | 95.6000 | 754.0000 | 320.0000 | 225.0000 | 9.56E+01nc |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes | - | 0.0956 | 0.1524 | - | - | - | 3040.0000 | 47800.0000 | 2860.0000 | 12600.0000 | 76200.0000 | 10800.0000 | 2.86E+03nc |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes | - | 0.0956 | 0.1524 | - | - | - | 3040.0000 | 47800.0000 | 2860.0000 | 12600.0000 | 76200.0000 | 10800.0000 | 2.86E+03nc |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes | - | 0.0002 | 0.0003 | - | - | - | 6.0800 | 95.6000 | 5.7200 | 25.1000 | 152.0000 | 21.6000 | 5.72E+00nc |

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# Site-specific

## Recreator Equation Inputs for Surface Water

*** Inputted values different from Recreator defaults are highlighted.**

| Variable | Recreator Surface Water Default Value | Form-input Value |
|---|---|---|
| $BW_{0-2}$ (body weight) kg | 15 | 15 |
| $BW_{2-6}$ (body weight) kg | 15 | 15 |
| $BW_{6-16}$ (body weight) kg | 80 | 44 |
| $BW_{16-30}$ (body weight) kg | 80 | 80 |
| $BW_{a}$ (body weight - adult) kg | 80 | 62 |
| $BW_{rec-a}$ (body weight - adult) kg | 80 | 62 |
| $DFW_{rec-adj}$ (age-adjusted dermal factor) $cm^2$-event/kg | 0 | 101610 |
| $DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) $cm^2$-event/kg | 0 | 319693.295 |
| $ED_{rec}$ (exposure duration - recreator) years | 26 | 26 |
| $ED_{0-2}$ (exposure duration) years | 2 | 2 |
| $ED_{2-6}$ (exposure duration) years | 4 | 4 |
| $ED_{6-16}$ (exposure duration) years | 10 | 10 |
| $ED_{16-30}$ (exposure duration) years | 10 | 10 |
| $ED_{rec-a}$ (exposure duration - adult) years | 20 | 20 |
| $EF_{rec-w}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{0-2}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{2-6}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{6-16}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{16-30}$ (exposure frequency) days/year | 0 | 45 |
| $EF_{rec-a}$ (adult exposure frequency) days/year | 0 | 45 |
| $ET_{0-2}$ (exposure time) hours/event | 0 | 2 |
| $ET_{2-6}$ (exposure time) hours/event | 0 | 2 |
| $ET_{6-16}$ (exposure time) hours/event | 0 | 2 |
| $ET_{16-30}$ (exposure time) hours/event | 0 | 2 |
| $ET_{rec-a}$ (adult exposure time) hours/event | 0 | 2 |
| $EV_{0-2}$ (events) events/day | 0 | 1 |
| $EV_{2-6}$ (events) events/day | 0 | 1 |
| $EV_{6-16}$ (events) events/day | 0 | 1 |
| $EV_{16-30}$ (events) events/day | 0 | 1 |
| $EV_{rec-a}$ (adult) events/day | 0 | 1 |
| THQ (target hazard quotient) unitless | 0.1 | 1 |
| $IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg | 0 | 4.181 |
| $IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg | 0 | 20.652 |
| $IRW_{0-2}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{2-6}$ (water intake rate) L/hour | 0.12 | 0.1 |
| $IRW_{6-16}$ (water intake rate) L/hour | 0.071 | 0.02 |
| $IRW_{16-30}$ (water intake rate) L/hour | 0.071 | 0.02 |
| $IRW_{rec}$ (water intake rate - adult) L/day | 0.071 | 0.02 |
| $IRW_{rec-a}$ (water intake rate - adult) L/hr | 0.071 | 0.02 |
| LT (lifetime - recreator) years | 70 | 70 |
| $SA_{0-2}$ (skin surface area) $cm^2$ | 6365 | 1770 |
| $SA_{2-6}$ (skin surface area) $cm^2$ | 6365 | 1770 |
| $SA_{6-16}$ (skin surface area) $cm^2$ | 19652 | 3820 |
| $SA_{16-30}$ (skin surface area) $cm^2$ | 19652 | 5790 |
| $SA_{rec}$ (skin surface area - adult) $cm^2$ | 19652 | 4805 |
| $SA_{rec-a}$ (skin surface area - adult) $cm^2$ | 19652 | 4805 |
| Apparent thickness of stratum corneum (cm) | 0.001 | 0.001 |
| TR (target risk) unitless | 0.000001 | 0.00001 |

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## Site-specific

### Recreator Regional Screening Levels (RSL) for Surface Water

**Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.**

| Chemical | CAS Number | Mutagen? | Volatile? | Chemical Type | $SF_o$ (mg/kg-day)$^{-1}$ | $SF_o$ Ref | RfD (mg/kg-day) | RfD Ref | RfC (mg/m$^3$) | RfC Ref | RAGSe GIABS (unitless) | $K_p$ (cm/hr) | MW | FA (unitless) | In EPD? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | 7440-36-0 | No | No | Inorganics | - | | 0.0004 | I | - | | 0.1500 | 0.0010 | 121.7600 | 1.0000 | Yes |
| Arsenic, Inorganic | 7440-38-2 | No | No | Inorganics | 1.5000 | I | 0.0003 | I | 0.0000 | C | 1.0000 | 0.0010 | 74.9220 | 1.0000 | Yes |
| Barium | 7440-39-3 | No | No | Inorganics | - | | 0.2000 | I | 0.0005 | H | 0.0700 | 0.0010 | 137.3300 | 1.0000 | Yes |
| Beryllium and compounds | 7440-41-7 | No | No | Inorganics | - | | 0.0020 | I | 0.0000 | I | 0.0070 | 0.0010 | 9.0100 | 1.0000 | Yes |
| Boron And Borates Only | 7440-42-8 | No | No | Inorganics | - | | 0.2000 | I | 0.0200 | H | 1.0000 | 0.0010 | 13.8400 | 1.0000 | Yes |
| Cadmium (Water) | 7440-43-9 | No | No | Inorganics | - | | 0.0005 | I | 0.0000 | A | 0.0500 | 0.0010 | 112.4000 | 1.0000 | Yes |
| Chromium(III), Insoluble Salt | 16065-83-1 | No | No | Inorganics | - | | 1.5000 | I | - | | 0.0130 | 0.0010 | 52.0000 | 1.0000 | Yes |
| Cobalt | 7440-48-4 | No | No | Inorganics | - | | 0.0003 | P | 0.0000 | P | 1.0000 | 0.0004 | 58.9300 | 1.0000 | Yes |
| Fluoride | 16984-48-8 | No | No | Inorganics | - | | 0.0400 | C | 0.0130 | C | 1.0000 | 0.0010 | 38.0000 | 1.0000 | Yes |
| Lithium | 7439-93-2 | No | No | Inorganics | - | | 0.0020 | P | - | | 1.0000 | 0.0010 | 6.9400 | 1.0000 | Yes |
| Mercuric Chloride | 7487-94-7 | No | No | Inorganics | - | | 0.0003 | I | 0.0003 | S | 0.0700 | 0.0010 | 271.5000 | 1.0000 | Yes |
| Molybdenum | 7439-98-7 | No | No | Inorganics | - | | 0.0050 | I | - | | 1.0000 | 0.0010 | 95.9400 | 1.0000 | Yes |
| Selenium | 7782-49-2 | No | No | Inorganics | - | | 0.0050 | I | 0.0200 | C | 1.0000 | 0.0010 | 78.9600 | 1.0000 | Yes |
| Thallium (Soluble Salts) | 7440-28-0 | No | No | Inorganics | - | | 0.0000 | X | - | | 1.0000 | 0.0010 | 204.3800 | 1.0000 | Yes |

| Chemical | $DA_{event(ca)}$ | $DA_{event(nc\ child)}$ | $DA_{event(nc\ adult)}$ | Ingestion SL TR=1E-05 (ug/L) | Dermal SL TR=1E-05 (ug/L) | Carcinogenic SL TR=1E-05 (ug/L) | Ingestion SL (Child) THQ=1 (ug/L) | Dermal SL (Child) THQ=1 (ug/L) | Noncarcinogenic SL (Child) THQ=1 (ug/L) | Ingestion SL (Adult) THQ=1 (ug/L) | Dermal SL (Adult) THQ=1 (ug/L) | Noncarcinogenic SL (Adult) THQ=1 (ug/L) | Screening Level (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Antimony (metallic) | - | 0.0041 | 0.0063 | - | - | - | 243.0000 | 2060.0000 | 218.0000 | 5030.0000 | 3140.0000 | 1930.0000 | 2.18E+02nc |
| Arsenic, Inorganic | 0.0002 | 0.0206 | 0.0314 | 40.7000 | 838.0000 | 38.9000 | 183.0000 | 10300.0000 | 179.0000 | 3770.0000 | 15700.0000 | 3040.0000 | 3.89E+01ca* |
| Barium | - | 0.9623 | 1.4652 | - | - | - | 122000.0000 | 481000.0000 | 97100.0000 | 2510000.0000 | 733000.0000 | 567000.0000 | 9.71E+04nc |
| Beryllium and compounds | - | 0.0010 | 0.0015 | - | - | - | 1220.0000 | 481.0000 | 345.0000 | 25100.0000 | 733.0000 | 712.0000 | 3.45E+02nc |
| Boron And Borates Only | - | 13.7476 | 20.9319 | - | - | - | 122000.0000 | 6870000.0000 | 120000.0000 | 2510000.0000 | 10500000.0000 | 2030000.0000 | 1.20E+05nc |
| Cadmium (Water) | - | 0.0017 | 0.0026 | - | - | - | 304.0000 | 859.0000 | 225.0000 | 6290.0000 | 1310.0000 | 1080.0000 | 2.25E+02nc |
| Chromium(III), Insoluble Salt | - | 1.3404 | 2.0409 | - | - | - | 913000.0000 | 670000.0000 | 386000.0000 | 18900000.0000 | 1020000.0000 | 968000.0000 | 3.86E+05nc |
| Cobalt | - | 0.0206 | 0.0314 | - | - | - | 183.0000 | 25800.0000 | 181.0000 | 3770.0000 | 39200.0000 | 3440.0000 | 1.81E+02nc |
| Fluoride | - | 2.7495 | 4.1864 | - | - | - | 24300.0000 | 1370000.0000 | 23900.0000 | 503000.0000 | 2090000.0000 | 405000.0000 | 2.39E+04nc |
| Lithium | - | 0.1375 | 0.2093 | - | - | - | 1220.0000 | 68700.0000 | 1200.0000 | 25100.0000 | 105000.0000 | 20300.0000 | 1.20E+03nc |
| Mercuric Chloride | - | 0.0014 | 0.0022 | - | - | - | 183.0000 | 722.0000 | 146.0000 | 3770.0000 | 1100.0000 | 851.0000 | 1.46E+02nc |
| Molybdenum | - | 0.3437 | 0.5233 | - | - | - | 3040.0000 | 172000.0000 | 2990.0000 | 62900.0000 | 262000.0000 | 50700.0000 | 2.99E+03nc |
| Selenium | - | 0.3437 | 0.5233 | - | - | - | 3040.0000 | 172000.0000 | 2990.0000 | 62900.0000 | 262000.0000 | 50700.0000 | 2.99E+03nc |
| Thallium (Soluble Salts) | - | 0.0007 | 0.0010 | - | - | - | 6.0800 | 344.0000 | 5.9800 | 126.0000 | 523.0000 | 101.0000 | 5.98E+00nc |

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