

**APPENDIX C –
MONITORED NATURAL ATTENUATION
EVALUATION**



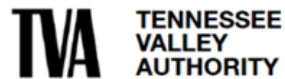
**Appendix C - Monitored Natural
Attenuation Evaluation Technical
Memorandum**

TDEC Commissioner's Order
Corrective Action / Risk Assessment
Allen Fossil Plant

October 30, 2025

Prepared for:

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REVISION LOG

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Sign-Off Sheet

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TABLE OF CONTENTS

ABBREVIATIONS	III
1.0 INTRODUCTION	1
2.0 BACKGROUND	3
2.1 Site Description	3
2.2 West Ash Disposal Area History	3
2.3 Hydrogeologic Framework	3
2.3.1 Hydrostratigraphic Units	4
2.3.2 Groundwater Monitoring System.....	4
2.3.3 Groundwater Flow	4
3.0 MONITORED NATURAL ATTENUATION ASSESSMENT	6
3.1 MNA Framework	6
3.2 Tier I – Demonstration of Arsenic and Molybdenum Stability	6
3.2.1 Major Ion Chemistry of Upgradient and Downgradient Groundwater	7
3.2.2 Distribution of Arsenic in the Uppermost Aquifer	7
3.2.3 Distribution of Molybdenum in the Uppermost Aquifer	8
3.2.4 Tier I Findings.....	9
3.3 Tier II – Determine Mechanism and Rate of Attenuation.....	9
3.3.1 Key Groundwater Chemistry Data	10
3.3.2 Soil Geochemistry Evaluation	11
3.3.3 Mechanisms of Arsenic Attenuation	12
3.3.4 Empirical Rate of Attenuation - Arsenic	12
3.3.5 Mechanisms of Molybdenum Attenuation	14
3.3.6 Empirical Rate of Attenuation - Molybdenum.....	14
3.3.7 Tier II Findings.....	15
3.4 Tier III Determine System Capacity and Evaluate Stability of Attenuation	15
3.5 Tier IV – Design Performance Monitoring.....	16
4.0 OVERALL SUMMARY AND CONCLUSION.....	17
5.0 REFERENCES	19



LIST OF TABLES

Table 1	Soil Geochemistry Boreholes and Sample Depths
Table 2	Minerals Identified by X-Ray Diffraction
Table 3	Non-Crystalline and Metal Hydroxide Sequential Extraction (SEP) Data for Iron and Arsenic

LIST OF EXHIBITS

Exhibit 1	ALF Plant Overview
Exhibit 2	West Ash Disposal Area Site Conceptual Model
Exhibit 3	WADA Groundwater Monitoring Network
Exhibits 4a-d	Piper Diagrams
Exhibit 5	Time Series of Arsenic Concentrations in West Ash Disposal Area Monitoring Wells
Exhibit 6	Time Series of Molybdenum Concentrations in West Ash Disposal Area Monitoring Wells
Exhibit 7	Time Series of Arsenic and Molybdenum Concentrations at ALF-208
Exhibit 8	Time Series of pH and Eh at ALF-208
Exhibit 9	Time Series of Sulfate at ALF-208
Exhibit 10	Empirical Attenuation Rate of Arsenic at ALF-208
Exhibit 11	Empirical Attenuation Rate of Molybdenum at ALF-208



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Abbreviations
October 30, 2025

ABBREVIATIONS

%	Percent
ACC	Allen Combined Cycle
amsl	above mean sea level
ALF	Allen Fossil Plant
CARA	Corrective Action/Risk Assessment
CCR	Coal combustion residuals
CSM	Conceptual Site Model
EADA	East Ash Disposal Area
EAR	Environmental Assessment Report
EI	Environmental investigation
GWPS	Groundwater Protection Standards
mg/kg	Milligrams per kilogram
MNA	Monitored natural attenuation
NPDES	National Pollutant Discharge Elimination System
ORP	Oxidation-reduction potential
SEP	Sequential Extraction Procedure
Stantec	Stantec Consulting Services Inc.
SU	Standard units
TDEC	Tennessee Department of Environment and Conservation
TOC	Total organic carbon
TVA	Tennessee Valley Authority
µg/L	Micrograms per liter
USEPA	United States Environmental Protection Agency
USACE	US Army Corps of Engineers
WADA	West Ash Disposal Area
XRD	X-ray diffraction



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Introduction
October 30, 2025

1.0 INTRODUCTION

On behalf of the Tennessee Valley Authority (TVA), Stantec Consulting Services Inc. (Stantec) has prepared this Technical Memorandum (TM) to summarize the initial Monitored Natural Attenuation (MNA) evaluation at TVA's former West Ash Disposal Area (WADA), Allen Fossil Plant (ALF Plant) in Memphis, Tennessee.

Coal combustion residuals (CCR) material located within the interior portion and surrounding dike at the former West Ash Disposal Area (WADA) was excavated and removed between November 2021 and November 2023. These closure activities effectively removed nearly 500,000 cubic yards of CCR material.

Since completion of the CCR material removal and closure activities, and as of May 2024, two rounds of groundwater sampling have been completed. Therefore, the available data primarily reflect groundwater quality prior to the removal of the CCR material. Given the limited post-CCR material removal groundwater dataset available to support the evaluation of MNA, TVA has identified groundwater extraction and treatment as a potential corrective action for the former WADA at this time. However, TVA will continue to perform routine groundwater monitoring at the former WADA and plans to collect additional geochemical data over the next two to three years. If future data and evaluations confirm that MNA will be effective, then TVA will coordinate with and obtain approval from TDEC to implement MNA as the corrective action. Otherwise, implementation of the identified corrective action of groundwater extraction and treatment will continue in accordance with the schedule provided in this CARA Plan.

The overall objective of the MNA evaluation is to demonstrate the effectiveness of MNA as a corrective action to address arsenic and molybdenum concentrations that occur above the groundwater protection standards (GWPS) at the former WADA. GWPS are provided in Table 1-1 of the CARA Plan. Monitoring wells ALF-207A, ALF-207B, ALF-208 and ALF-208B, located downgradient (north) of the former WADA coal combustion residuals (CCR) unit, currently exhibit concentrations of molybdenum greater than the GWPS. Monitoring Wells ALF-219B and ALF-208, located south and north of the former WADA, respectively, exhibit concentrations of arsenic statistically greater than the GWPS. Monitoring well ALF220B, located south of the former WADA, has consistently exhibited arsenic concentrations above the GWPS since its installation in 2022, but as of May 2024 there were an insufficient number of sampling results to complete a statistical evaluation of these data. This evaluation supports and fulfills requirements of the Tennessee Department of Environmental and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to TVA (TDEC 2015).

The TDEC Order sets forth a "process for the investigation, assessment, and remediation of unacceptable risks" at the TVA's coal ash disposal sites in Tennessee. The Corrective Action/Risk Assessment (CARA) Plan is being prepared pursuant to the TDEC Order process to evaluate whether unacceptable risks related to management of CCR material exists at the ALF Plant, specify the actions TVA plans to take at the CCR units and the basis of those actions, and incorporate other operational changes planned or in progress by TVA.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Introduction

October 30, 2025

This MNA Evaluation TM, to the extent possible, was prepared following the tiered approach provided in the U.S. Environmental Protection Agency (USEPA) Guidance (2015) on the “*Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites.*”

The specific objectives of the MNA evaluation are summarized as follows:

- Demonstrate that the region of arsenic and molybdenum concentrations in groundwater above the GWPS is not expanding
- Determine the mechanism(s) and estimated rate of arsenic and molybdenum attenuation
- Determine the long-term capacity for arsenic and molybdenum attenuation and stability of immobilized fractions
- Design a performance monitoring program.



Background
October 30, 2025

2.0 BACKGROUND

2.1 SITE DESCRIPTION

The ALF Plant is a retired TVA coal-fired power plant in Shelby County in the southwest corner of Memphis, Tennessee. Operations ceased in March 2018, after which TVA began removal of physical structures associated with the retired coal-fired plant units. During operations, CCR material was managed in two onsite units: the East Ash Disposal Area (EADA) and the former WADA (Exhibit 1). The EADA is east of the former power plant, and the US Army Corps of Engineers (USACE) levee forms its northern dike. The former WADA is west of the retired power plant, and the USACE levee forms its southern dike. The TVA Allen Combined Cycle (ACC) plant, which replaced the fossil plant, is located to the south. The EADA ceased receiving CCR in 2018, and plant discharges to the former WADA ceased in 1992 (Stantec 2019). By the end of 2023, the removal of CCR from the former WADA was complete, and CCR material removal from the EADA was in progress.

The remainder of this MNA evaluation TM focuses on the former WADA CCR unit - more specifically the arsenic and molybdenum concentrations detected above the GWPS in groundwater monitoring wells ALF-207A, ALF-207B, ALF-208, ALF-208B, ALF-219B, and ALF-220B.

2.2 WEST ASH DISPOSAL AREA HISTORY

The 39.5-acre former WADA is located west of the former power plant. The USACE levee forms the south dike of the former WADA. The former WADA does not appear to have been subdivided during its construction or periods of operation for the purpose of CCR management.

The former WADA ceased receiving CCR material in 1992, although it continued to be a National Pollutant Discharge Elimination System (NPDES) regulated unit. In late 2021, TVA began removing CCR material from the former WADA and finished CCR material removal in November 2023.

The majority of the former WADA currently consists of grassland (herbaceous) vegetation and lacks standing surface water conditions. The turf grass was placed following CCR material removal, backfilling, and grading.

2.3 HYDROGEOLOGIC FRAMEWORK

The ALF Plant is located on top of the Mississippi Embayment, in the Mississippi Alluvial Plain of the Gulf Coastal Plain on the south shore of McKellar Lake and the eastern bank of the Mississippi River. The Mississippi Embayment is a geologic basin filled with 3000 feet or more of Cretaceous to Recent age sediments deposited primarily in a coastal Plain Setting. The sedimentary sequence is dominated by unconsolidated sand, silt, and clay with minor lignite (Hosman and Weiss 1991).

These hydrostratigraphic units are discussed in the following sections, and additional details pertaining to the geology and hydrogeology of the ALF Plant and surrounding area are presented in *Environmental Assessment Report* (EAR) (TVA 2024).



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Background
October 30, 2025

2.3.1 Hydrostratigraphic Units

Site-specific geologic mapping indicates the ALF Plant is directly underlain by artificial fill and Quaternary age alluvial deposits. The fill generally consists of material dredged from McKellar Lake, materials from cut and fill excavations from the surrounding floodplain, and possibly loess in certain locations. The fill can range in thickness from a few feet to tens of feet beneath industrial areas in the floodplain. Site-specific observations of the Mississippi River Valley alluvium deposits (hydrogeologically referred to as the Alluvial aquifer) indicate that this unit is a silty sand with intervals of silts and clay in the upper portion of the unit and gravel in the lower portion. These observations are consistent with the regional understanding of this deposit (Hosman and Weiss 1991). Site-specific geologic investigations indicate that the uppermost alluvial aquifer is underlain by the fine-grained upper Claiborne confining unit. The upper Claiborne unit is underlain by the Memphis Aquifer, which is characterized by predominantly very fine to coarse-grained sand with lenses of fine-grained material (Parks and Carmichael 1990). A cross-section of the former WADA is presented on Exhibit 2.

2.3.2 Groundwater Monitoring System

The groundwater monitoring wells considered in this initial MNA evaluation for the former WADA include the following, which are shown in Exhibit 3 (except for ACC-3A and ACC-5B which are located south of the area shown in Exhibit 3):

- South of the former WADA: ACC-3A (background well), ACC-5B (background well), ALF-219B, and ALF-220B
- North of the former WADA: ALF-207A, ALF-207B, ALF-208, and ALF-208B

These wells were installed in the Alluvial aquifer above the Claiborne confining unit, with the Alluvial aquifer defined as the uppermost aquifer in the vicinity of the WADA. These wells are screened in the shallow, intermediate, and deep intervals of the Alluvial aquifer to provide spatial and vertical delineation.

2.3.3 Groundwater Flow

The former WADA overlies the uppermost Alluvial aquifer, which is a thick (approximately 100 to 250 feet) deposit of sand, silt, and clay deposited by the ancestral Mississippi River. Groundwater flow in the uppermost alluvial aquifer is predominantly horizontal, and flow direction is influenced by the McKellar Lake stage. Below the uppermost alluvial aquifer is the Claiborne confining unit, which is a clay layer at least 100 feet thick that separates the uppermost alluvial aquifer from the lower Memphis Aquifer (Stantec 2024).

Groundwater elevations in the uppermost alluvial aquifer fluctuate with the McKellar Lake stage, but generally range from 180-205 feet above mean sea level (amsl). Vertical groundwater gradients calculated at the ALF Plant indicate relatively small vertical hydraulic gradients within the uppermost alluvial aquifer, and most gradients between the shallow and deep units are upward. The horizontal flow within the uppermost aquifer is dependent on the stage of McKellar Lake, which can vary by up to 40 feet and cause reversal in flow direction. During regular to low water levels at McKellar Lake groundwater flows to the north toward McKellar Lake. During periods of high river stage in the Mississippi River, and



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Background
October 30, 2025

therefore McKellar Lake, the flow reverses to the south toward the former WADA. Overall, the net groundwater flow is from the south, toward McKellar Lake to the north. Figures depicting groundwater flow directions are provided in the EAR (TVA 2024).



Monitored Natural Attenuation Assessment
October 30, 2025

3.0 MONITORED NATURAL ATTENUATION ASSESSMENT

3.1 MNA FRAMEWORK

The framework for the tiered approach to evaluate MNA is predicated on a condition that includes an active source influencing the receiving groundwater. However, the CCR material at the former WADA was removed as of November 2023.

Groundwater concentration trends to date demonstrate how the former WADA groundwater may have been affected by CCR material removal and closure activities commencing in November 2021 and concluding in November 2023. Examples during this two-year period are as follows:

- At downgradient well ALF-208, the arsenic concentration temporarily increased in early 2023, followed by a decreased concentration for the most recent available data (May 2024). A similar response was observed for molybdenum in well ALF-208.
- During this same time frame, downgradient monitoring wells ALF-207A, ALF-207B, and ALF-208B exhibited molybdenum concentrations above the GWPS with a muted response, as compared to ALF-208. The most recent data for these three wells (February and May 2024) showed a decrease in molybdenum concentrations from the previous sampling event.

Thus, a component of the Tier I analysis will be to evaluate the change in arsenic concentrations in downgradient well ALF-208 and molybdenum concentrations in downgradient wells ALF-207A, ALF-207B, ALF-208, and ALF-208B. As will be demonstrated in the following sub-sections, the effect of the CCR unit on groundwater quality has been limited and the assessment of MNA is conducted in the context of diminishing influence of pore water on groundwater quality following CCR material removal activities.

Groundwater sampling has been conducted at the former WADA since 2016. The sampling history and analytical datasets are presented in the EAR (TVA 2023). As described in the EAR, the only constituents with concentrations above the GWPS in the uppermost aquifer at the former WADA are arsenic and molybdenum, which were detected in specific monitoring wells. Four downgradient monitoring wells have been affected: ALF-207A (molybdenum), ALF-207B (molybdenum), ALF 208 (arsenic and molybdenum), and ALF-208B (molybdenum). As explained in the CARA Plan, corrective action at the former WADA is only required for groundwater in order to attain the arsenic and molybdenum GWPS at downgradient wells ALF-207A, ALF-207B, ALF-208, and ALF-208B, consistent with regulatory requirements.

3.2 TIER I – DEMONSTRATION OF ARSENIC AND MOLYBDENUM STABILITY

The objective of the Tier I evaluation is to demonstrate stability of arsenic and molybdenum concentrations in former WADA groundwater (i.e., not expanding or migrating) as a result of ongoing natural attenuation mechanisms. Uppermost aquifer groundwater monitoring wells around the former WADA are shown in Exhibit 3.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

3.2.1 Major Ion Chemistry of Upgradient and Downgradient Groundwater

Changes in groundwater chemistry indicate that pore water influence on groundwater in the downgradient portion of the former WADA has diminished following the CCR material removal and closure activities. As an introduction to the discussion regarding arsenic and molybdenum stability, the temporal major ion distribution is discussed in relation to the groundwater both upgradient and downgradient of the former WADA to provide a frame of reference for how CCR material removal and closure activities may correlate with groundwater concentration trends.

Relative proportions of cations and anions from downgradient wells (ALF-207A, ALF-207B, ALF-208, and ALF-208B) and background wells (ACC-3A and ACC-5B) from December 2021 through May 2024 are shown on a series of Piper diagrams (Exhibit 4a-d). Major ion data indicates that background groundwater from ACC-3A and ACC-5B is calcium-bicarbonate type, meaning that the most abundant cation is calcium, and the most abundant anion is bicarbonate (Exhibit 4a). Although pore water data were not available for the historical CCR material in the former WADA, CCR pore water generally exhibits a characteristic that is calcium-sulfate type, meaning that the most abundant cation is calcium, and the most abundant anion is sulfate. The effects of such CCR material influence on groundwater is evident in ionic groundwater signatures at downgradient wells ALF-207A, ALF-207B, and ALF-208. Prior to CCR material removal and closure, groundwater at ALF-208 was calcium-bicarbonate-sulfate type (Exhibit 4b), while groundwater at ALF-207A and ALF-207B were calcium-bicarbonate with 40 percent (%) and 30% sulfate, respectively (Exhibits 4c and 4d).

The groundwater composition of major ions at ALF-207A and ALF-208 has shifted over time, trending away from their 2021 water-types toward a composition with increased bicarbonate and decreased sulfate, a signature that is more like the calcium-bicarbonate water type of background wells ACC-3A and ACC-5B. This water type shift indicates that CCR material-related influence has lessened in the downgradient area of the former WADA following CCR material removal.

3.2.2 Distribution of Arsenic in the Uppermost Aquifer

Evaluation of the site data indicates that arsenic concentrations in the groundwater downgradient of the former WADA are stable to decreasing, that downgradient arsenic concentrations above the GWPS are isolated to the vicinity of ALF-208, and that the only other exceedances of arsenic GWPS observed in the vicinity of the former WADA are on the southeastern perimeter in wells ALF-219B and ALF-220B. Arsenic concentrations in background wells ACC-3A and ACC-5B have been stable and less than 1 micrograms per liter ($\mu\text{g/L}$) since the wells were installed in 2020 (Exhibit 5). Concentrations of arsenic in ALF-208 averaged approximately 7.13 $\mu\text{g/L}$ during the pre-CCR material removal period, showing relatively stable concentrations fluctuating within a narrow range below or slightly above the GWPS (Exhibit 5). Following the onset of CCR material removal and closure activities at the former WADA, arsenic concentrations at ALF-208 increased to a peak at 69.7 $\mu\text{g/L}$ on March 3, 2023. Arsenic concentrations at ALF-208 have since shown a decline toward the GWPS of 10 $\mu\text{g/L}$. This trend has occurred following the latter portion of the closure activities, which included the removal of CCR material from the northern dike of the former WADA, such that CCR material is no longer present in the area immediately upgradient of well ALF-208. This decreasing trend is indicative of a reduction in CCR-related influence on groundwater in the



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

downgradient area after late 2023/early 2024. There are no other wells downgradient of the former WADA that have arsenic concentrations above the GWPS.

Upgradient monitoring wells ALF-219B and ALF-220B, both screened in the intermediate zone of the uppermost aquifer also exhibit arsenic concentrations above the GWPS. Monitoring well ALF-220B has exhibited relatively stable arsenic concentrations with an average of 14 µg/L, and a high value of 18.6 µg/L, since it was installed in early 2023. Monitoring well ALF-219B exhibits higher arsenic concentrations (average of 64.6 µg/L), with fluctuating concentrations that were most predominant during active CCR material removal and closure activities. Following the completion of CCR material removal and closure activities, arsenic concentrations at ALF-219B have begun to decline from a high of 86.0 µg/L in December 2023 to 55.8 µg/L in May 2024. This decreasing trend is expected to continue with future sampling events. Although there is limited post-CCR material removal and closure data for the former WADA monitoring wells, the decreasing concentrations at downgradient well ALF-208 and upgradient well ALF-219B suggest that the area of groundwater with arsenic concentrations greater than the GWPS is stable or more likely decreasing.

3.2.3 Distribution of Molybdenum in the Uppermost Aquifer

Evaluation of the site data indicates that molybdenum concentrations in the groundwater downgradient of the former WADA are stable to decreasing, and that downgradient molybdenum concentrations above the GWPS are isolated to the vicinity of ALF-207A, ALF-207B, ALF-208, and ALF-208B. Molybdenum concentrations in background wells ACC-3A and ACC-5B have been stable and less than 1 µg/L since they were installed in 2020 (Exhibit 6). Concentrations of molybdenum in downgradient well ALF-208 (historical high) averaged approximately 1,250 µg/L during the pre-CCR removal period, showing large seasonal fluctuations between 253 µg/L and 2,300 µg/L (Exhibit 6). Following the onset of CCR material removal and closure activities in the former WADA, molybdenum concentrations at ALF-208 began to decrease with more muted seasonal fluctuations. Molybdenum concentrations at ALF-208 have since decreased to a three-year low of 723 µg/L (May 2024), with data suggesting a continued decreasing trend. This apparent decreasing trend developed following the latter portion of the closure activities, which included the removal of CCR material from the northern dike of the former WADA such that CCR material is no longer present in the area immediately upgradient of well ALF-208. This decreasing trend suggests a reduction in CCR-related influence on groundwater in the downgradient area after late 2023/early 2024.

The three deeper wells (ALF-207A, ALF-207B, and ALD-208B) on the downgradient edge of the former WADA that exhibit molybdenum concentrations above the GWPS show relatively stable concentrations with muted responses to the CCR material removal and closure activities, exhibiting a range in concentrations at the three wells between roughly 175 – 500 µg/L. Further data collection and evaluation is required to complete the MNA evaluation for these downgradient wells, however the overall data suggests that the area of groundwater with molybdenum concentrations greater than the GWPS is stable, if not decreasing. No upgradient monitoring wells exhibit concentrations of molybdenum greater than the GWPS.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

3.2.4 Tier I Findings

Recent CCR material removal and closure activities at the former WADA have eliminated the potential for CCR material-related constituents to be released to groundwater in the uppermost aquifer. Arsenic concentrations in groundwater at downgradient well ALF-208 and upgradient well ALF-219B exhibited a period of greater fluctuations and concentrations that appear to coincide with the period of closure activities. Both monitoring wells appear to show an ongoing decreasing trend during and/or after the latter portion of the closure activities, which included the removal of CCR material from the northern dike such that CCR material is no longer present in the area immediately upgradient of well ALF-208 and downgradient of well ALF-219B. The shifting major ion composition of groundwater at ALF-208 (toward a more concentrated calcium-bicarbonate composition with less sulfate) aligns with decreasing trends of arsenic concentrations and suggests that CCR-related influence on groundwater at ALF-208 will continue to diminish with time.

Similar to the trend observed for arsenic, molybdenum concentrations have exhibited a decreasing trend in downgradient monitoring well ALF-208. Although molybdenum trends for this well have historically exhibited large seasonal fluctuations, since the onset of CCR material removal and closure activities, the fluctuations have become muted, and a decreasing trend is suggested by recent data. Molybdenum concentrations in intermediate and deep downgradient monitoring wells appear stable following CCR removal from the WADA.

Based on the available groundwater monitoring data, arsenic and molybdenum concentrations in downgradient former WADA groundwater appear stable or decreasing, with shallow concentrations above the GWPS in the vicinity of ALF-208 exhibiting a distinct decrease. This evaluation suggests that the USEPA Tier I criteria are satisfied in that the region of groundwater exhibiting arsenic and molybdenum concentrations above GWPS is not expanding or migrating (i.e., stable and limited to known wells), and well ALF-208 has exhibited a recent decreasing trend for both arsenic and molybdenum concentrations. Furthermore, upgradient well ALF-219B appears to exhibit a recent decreasing trend in arsenic, suggesting that the potentially impacted area is shrinking in size. Continued data collection and analysis will improve the understanding of recent apparent trends in groundwater concentrations, thereby enhancing the findings of this Tier I evaluation.

3.3 TIER II – DETERMINE MECHANISM AND RATE OF ATTENUATION

The objective of Tier II assessment is to determine the mechanisms and estimated rates of arsenic and molybdenum attenuation at the site. This further leads to an evaluation of whether MNA processes could achieve corrective action objectives (i.e., attain the arsenic and molybdenum GWPS at downgradient wells), based on current geochemical conditions at the site.

As discussed in the following sections, attenuation of arsenic is occurring by adsorption onto iron hydroxide minerals, such as ferrihydrite, within the unconsolidated materials. Natural attenuation of molybdenum also occurs through adsorption, although it is considered relatively weak compared to arsenic at pH values above 6.0 SU. Attenuation through co-precipitation is possible, however this



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

mechanism requires specific conditions to occur (i.e., sulfate-reducing or calcium-rich waters and higher temperatures).

Based on current observations, arsenic concentrations at downgradient well ALF-208 and upgradient well ALF-219B are estimated to decline below the GWPS within approximately one to five years. Molybdenum concentrations at downgradient wells ALF-207A, ALF-208, and ALF-208B are estimated to decline below the GWPS within seven to 15 years. These attenuation time frames are based on limited post-CCR removal data, and calculation of an attenuation rate for monitoring well ALF-207B is not possible at this time. Attenuation rates will be further refined with continued sampling and data evaluation.

3.3.1 Key Groundwater Chemistry Data

Groundwater chemistry at ALF-208 has been monitored since November 2016, whereas other monitoring wells pertinent to this discussion were installed in 2019 or later. In addition, groundwater chemistry at ALF-208 shows the most immediate response to closure activities that were completed a relatively short time ago (November 2023). Although attenuation rate calculations are possible for all wells where concentrations of arsenic and/or molybdenum are above a GWPS with the exception of ALF-207B, the current decreasing trends are not as distinctive. For these reasons, the discussion below focuses on data related to ALF-208, although the same analysis is expected to become applicable to all monitoring wells with further data collection and analysis given the current trends in groundwater chemistry. The available ALF-208 data for arsenic and molybdenum, along with several geochemical parameters important to their attenuation are summarized as follows:

- Prior to initiation of CCR material removal in November 2021, arsenic concentrations at ALF-208 fluctuated within a narrow range of 1.9 to 11.5 µg/L and were typically below the 10 µg/L GWPS. During CCR material removal activities, concentrations of arsenic increased to a maximum of 69.7 µg/L (Exhibit 6) and then began trending downward. The CCR material removal and closure activities were completed in November 2023, and arsenic concentrations in groundwater at ALF-208 continue to show a decreasing trend from the peak in March 2023 to the most recent available concentration of 13.8 µg/L in May 2024 (Exhibit 7). The recent decreasing trend suggest that source removal coupled with natural attenuation mechanisms could reduce arsenic concentrations in the shallow alluvial groundwater.
- Prior to initiation of CCR material removal in November 2021, molybdenum concentrations at ALF-208 exhibited seasonal fluctuations ranging from 253 to 2,300 µg/L, with an average concentration of 1,250 µg/L (Exhibit 7). Immediately following onset of CCR material removal activities, concentrations of molybdenum decreased, and the seasonal fluctuations became muted. When the former WADA closure activities concluded in November 2023, molybdenum concentrations continued to decrease from a peak of 2,300 µg/L in September 2021 to the most recent available concentration of 723 µg/L in May 2024 (Exhibit 7). The recent decreasing trend indicates that source removal coupled with natural attenuation mechanisms are reducing molybdenum concentrations in the shallow alluvial groundwater.
- The measured field pH generally ranges between 6.50 to 6.85 standard units (SU) with an average of 6.72 SU and has remained relatively stable, with an anomalous period during CCR



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

material removal activities, where it temporarily decreased to 6.39 and 6.19 SU for two sampling events (Exhibit 8).

- The oxidation-reduction potential (ORP), adjusted to Eh (reduction potential), ranged between 82.8 to 399.2 mV (-117.2 to 199.2 mV field measurement) (Exhibit 8). There has been no discernable change in ORP since closure activities concluded.
- Concentrations of sulfate ranged from 41 to 584 mg/L (Exhibit 9). Historically, sulfate exhibited large fluctuations, perhaps due to seasonality in groundwater flow directions. Following completion of closure activities in late 2023, the fluctuation trend appears to be muted. Further sampling and data evaluation will confirm this behavior.

3.3.2 Soil Geochemistry Evaluation

Samples of unconsolidated material were collected to evaluate geochemical characteristics to determine the chemical and mineralogical composition of subsurface material and the capacity of unconsolidated material for adsorption and attenuation of arsenic and molybdenum from groundwater. Evaluation of the unconsolidated material shows that ample amorphous solids, particularly non-crystalline and metal hydroxide fractions, are available for attenuation. Material samples collected for geochemical evaluation were obtained from three locations as listed in Table 1 and shown in Exhibit 3. These locations were selected to investigate the unconsolidated material geochemistry of unconsolidated material across the site to identify mineralogy that supports arsenic and molybdenum attenuation. Samples were collected at depths ranging from 39.5 to 155.5 feet below ground surface, from an approximate elevation spanning the shallow to intermediate alluvial aquifer. Analyses included measurements of unconsolidated material pH, total organic carbon (TOC), total sulfur and sulfur species, mineralogy via X-ray diffraction (XRD), and a sequential extraction procedure (SEP).

XRD provides a bulk analysis of unconsolidated material mineralogy. Minerals identified via XRD include (in decreasing order of abundance) quartz, albite, microcline, illite/mica, chlorite, and dolomite (Table 2).

SEP data includes estimates of metal partitioning among different mineral fractions as distinguished through seven sequential steps, which are defined as (in order of extraction) exchangeable, carbonate, non-crystalline, metal hydroxide, organic, acid sulfide, and residual. Aluminum and iron associated with the non-crystalline and metal hydroxides are considered the primary extraction steps to quantify potential for arsenic and molybdenum attenuation (Table 3). Exchangeable, carbonate, organic, acid sulfide, and residual fractions are either minor in influence (exchangeable, carbonate) or are not expected to influence arsenic and molybdenum groundwater chemistry due to limited solubility/geochemical reactivity (organic-bound, acid sulfide, residual).

Combining results for the non-crystalline and metal hydroxide steps, the arsenic content of unconsolidated material ranged between 0.28 and 0.99 milligrams per kilogram (mg/kg) with an estimated geometric mean of 0.58 mg/kg for non-crystalline. Arsenic was not detected above the reporting limit in the metal-hydroxide step. For this evaluation, the assumption is made that the total mass of arsenic bound in the unconsolidated material with the non-crystalline and metal hydroxide fractions is representative of the mass of arsenic attenuated by the unconsolidated material during historical operations. This range of values is used as a basis for establishing that attenuation of arsenic has



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

occurred in the uppermost aquifer at the downgradient side of former WADA, while acknowledging the material evaluated is not in the vicinity where arsenic attenuation is likely to have already occurred.

Iron content in the non-crystalline phases was between 491 and 5,050 mg/kg with a geometric mean of 1,254 mg/kg, while the metal hydroxide phases ranged between 1,250 and 2,880 mg/kg with a geometric mean of 1,775 mg/kg. Aluminum content in the non-crystalline phases was between 26.7 and 162 mg/kg with a geometric mean of 71.0 mg/kg, while the metal hydroxide phases ranged between 267 and 1,280 mg/kg with a geometric mean of 524 mg/kg. Table 3 lists results of iron, aluminum, and arsenic extraction for the non-crystalline and metal hydroxide steps for samples tested. These results indicate that changes in attenuated arsenic and iron concentrations within the unconsolidated material may occur vertically across the Alluvial aquifer. The variability in composition with depth also indicates that the presence of iron, aluminum, arsenic, and, by proxy, molybdenum within the Alluvial aquifer is heterogeneous and may contribute to observed arsenic and molybdenum concentrations in groundwater at downgradient wells.

In summary, the soil geochemistry evaluation indicates that the subsurface material exhibits characteristics that promote the attenuation of arsenic and molybdenum from groundwater through adsorption onto amorphous phases such as iron hydroxides depending on pH and oxidation-reduction conditions.

3.3.3 Mechanisms of Arsenic Attenuation

Arsenic concentrations in groundwater are subject to pH-controlled adsorption at iron hydroxide adsorption sites. At this time, the available post-removal groundwater dataset is insufficient to complete and calibrate a geochemical model.

3.3.4 Empirical Rate of Attenuation - Arsenic

An assessment of the rate of attenuation projects that the arsenic concentration at well ALF-208 will fall below the 10 µg/L GWPS within the next one to five years. Arsenic has been attenuated within the unconsolidated materials upgradient of the former WADA as indicated by the presence of arsenic in non-crystalline (amorphous phase) SEP fractions. The quantity of arsenic measured in amorphous fractions of unconsolidated materials is interpreted as the culmination of arsenic adsorption that occurred on the upgradient fringes of the former WADA, thereby providing a conservative representation of adsorption potential.

Following CCR material removal and closure at the former WADA, lower concentrations of sulfate and changes in major ion distribution indicate a decreasing CCR-related influence on the groundwater system (Exhibit 9). This indicates that geochemical conditions in the aquifer likely represent a trailing gradient condition (ITRC 2010), such that the arsenic currently observed in the groundwater at ALF-208 is a function of the interaction between unconsolidated materials that have been historically loaded with arsenic and influent source(s) of groundwater.

The empirical attenuation rate was calculated using the point decay method (Newell et al. 2002), where the first-order decay for a constituent is provided in Equation 1:

$$C_t = C_0 e^{kt} \quad (\text{Equation 1})$$



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

where C_0 is the initial concentration, C_t is the concentration at time t , t is the amount of time in years that have elapsed since C_0 , and k is the first-order decay constant (per year).

Using the method of Newell et al. (2002) a semi-logarithmic plot of the arsenic concentration versus time, from the 69.7 µg/L peak concentration in March 2023 through the most recent available concentration of 13.8 µg/L in May 2024, yields a best fit trend line with the equation:

$$C_t = 74.934e^{-1.411t} \quad (\text{Equation 2})$$

where 74.934 is the arsenic concentration in µg/L at the y-intercept and -1.411 is the slope of the trend line (Exhibit 10). The slope of the trend line equates to the first-order decay constant (k) in Equation 1 in units of per year (i.e., $k = -1.411/\text{year}$), where the negative value indicates a rate of decrease (decay).

Rearranging Equation 1, the time for the arsenic concentration at ALF-208 to fall below the GWPS can be estimated by:

$$t = \frac{\ln\left[\frac{C_t}{C_0}\right]}{k} \quad \text{or} \quad t = \frac{\ln\left[\frac{C_{GWPS}}{69.7}\right]}{-1.411}$$

Where 69.7 is the arsenic concentration (C_0) in µg/L at its maximum concentration on March 7, 2023, the concentration at time t (C_t) is the 10 µg/L GWPS (shown as C_{GWPS}), and k is $-1.411/\text{year}$ as determined above. This calculation yields an estimated timeframe of approximately 1.4 years for the arsenic concentration at well ALF-208 to decrease from the March 7, 2023, peak concentration to below the GWPS.

The same method was used to calculate an attenuation rate for upgradient monitoring well ALF-219B, which has exhibited historically high arsenic concentrations since its installation in 2019. Arsenic concentrations have ranged from 34.5 µg/L to 86.3 µg/L, with an average of 63.2 µg/L until CCR material removal and closure was completed. Following closure, the arsenic concentrations appear to be on a downward trend from a maximum of 86.0 µg/L on December 12, 2023, to a low of 55.8 µg/L at the most recent time of sampling on May 17, 2024. Using the same equations as above, 86.3 is the arsenic concentration (C_0) in µg/L at its maximum concentration on December 12, 2023, the concentration at time t (C_t) is the 10 µg/L GWPS (shown as C_{GWPS}), and k is $-0.977/\text{year}$. This calculation yields an estimated timeframe of approximately 2.2 years for the arsenic concentration at well ALF-219B to decrease from the December 12, 2024, peak concentration to below the GWPS. Considering the historical fluctuations in arsenic concentrations in this well, and the limited post-CCR removal sampling data, additional sample collection and data evaluation is required to confirm the rate of attenuation.

Although these estimates are based directly on ALF-208 and ALF-219 arsenic concentration data, the methodology is a simple mathematical projection of the decreasing concentration trend and does not account for variability in future groundwater data or conditions or consider specific geochemical processes. There is further uncertainty associated with the potential influence of reversal in groundwater flow driven by fluctuations in McKellar Lake stage, and because of the limited amount of post-CCR removal groundwater data available for use in the calculations. Considering these uncertainties, a more general estimate is that the arsenic concentration on the downgradient edge of the former WADA will fall below the 10 µg/L GWPS within the next one to five years. This estimate will be updated following the collection of additional post-CCR removal groundwater data near the former WADA.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

3.3.5 Mechanisms of Molybdenum Attenuation

Molybdenum concentrations in groundwater are subject to pH-controlled adsorption at iron hydroxide adsorption sites, with the most efficient attenuation occurring at pH values less than or equal to 6.0 SU. Unlike arsenic, there is no direct evidence in the geochemistry data set that indicates molybdenum has been attenuated within the unconsolidated materials upgradient of the former WADA. Molybdenum was not detected in either the non-crystalline (amorphous phase) or metal hydroxide SEP fractions. Additional soil sampling downgradient of the former WADA will provide the necessary geochemical data to evaluate current attenuation mechanisms for molybdenum at the former WADA.

At this time, the post-CCR removal groundwater dataset is insufficient to complete and calibrate a geochemical model.

3.3.6 Empirical Rate of Attenuation - Molybdenum

Following the removal of CCR material from the former WADA changes in major ion distribution indicate a decreasing CCR-related influence on the groundwater system (Exhibit 11). This indicates that geochemical conditions in the aquifer likely represent a trailing gradient condition (ITRC 2010), such that the molybdenum currently observed in the groundwater at ALF-208 is a function of the interaction between unconsolidated materials that have been historically loaded with molybdenum and influent source(s) of groundwater.

The empirical attenuation rate was calculated using the point decay method (Newell et al. 2002), where the first-order decay for a constituent is provided in Equation 1:

$$C_t = C_0 e^{kt} \quad (\text{Equation 1})$$

where C_0 is the initial concentration, C_t is the concentration at time t , t is the amount of time in years that have elapsed since C_0 , and k is the first-order decay constant (per year).

Using the method of Newell et al. (2002) a semi-logarithmic plot of the molybdenum concentration versus time, from the 2,300 $\mu\text{g/L}$ peak concentration in September 2021 through the most recent available concentration of 723 $\mu\text{g/L}$ in May 2024, yields a best fit trend line with the equation:

$$C_t = 2025.9e^{-0.452t} \quad (\text{Equation 2})$$

where 2025.9 is the molybdenum concentration in $\mu\text{g/L}$ at the y-intercept and -0.452 is the slope of the trend line (Exhibit 11). The slope of the trend line equates to the first-order decay constant (k) in Equation 1 in units of per year (i.e., $k = -0.452/\text{year}$), where the negative value indicates a rate of decrease (decay).

Rearranging Equation 1, the time for the molybdenum concentration at ALF-208 to fall below the GWPS can be estimated by:

$$t = \frac{\ln\left[\frac{C_t}{C_0}\right]}{k} \quad \text{or} \quad t = \frac{\ln\left[\frac{C_{\text{GWPS}}}{2300}\right]}{-0.452}$$

Where 2,300 is the molybdenum concentration (C_0) in $\mu\text{g/L}$ at its maximum concentration on September 10, 2021, the concentration at time t (C_t) is the 100 $\mu\text{g/L}$ GWPS (shown as C_{GWPS}), and k is $-0.452/\text{year}$



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

as determined above. This calculation yields an estimated timeframe of approximately 6.9 years for the molybdenum concentration at well ALF-208 to decrease from the March 7, 2023, peak concentration to below the GWPS.

Although these estimates are based directly on downgradient well ALF-208 molybdenum concentration data, the methodology is a simple mathematical projection of the decreasing concentration trend and does not account for variability in future groundwater data or conditions or consider specific geochemical processes. There is further uncertainty associated with the potential influence of reversal in groundwater flow driven by fluctuations in McKellar Lake stage, and because of the limited amount of post-CCR removal groundwater data available for use in the calculations. Considering these uncertainties, a more general estimate is that the molybdenum concentration at all downgradient monitoring wells will fall below the 100 µg/L GWPS within the next seven to 15 years.

3.3.7 Tier II Findings

Based on the evaluation described in this sub-section, attenuation of arsenic and molybdenum in the post-CCR removal groundwater system at the former WADA is likely to occur by adsorption onto hydroxide minerals such as ferrihydrite and/or gibbsite within the unconsolidated materials. The period of higher arsenic concentrations and greater fluctuations at well ALF-208 coincided with the period during which the CCR material removal and closure activities took place, and the arsenic behavior at ALF-208 was likely temporary and related to system disturbances associated with the closure activities. The CCR material was removed from the area immediately upgradient of monitoring wells ALF-207A, ALF-207B, ALF-208, and ALF-208B as part of the closure activities, and so there will be no further CCR-related arsenic or molybdenum influence on the upgradient groundwater. The empirical attenuation rate was evaluated and, considering uncertainties, resulted in an estimate that the arsenic concentration at downgradient well ALF-208 will decline below the GWPS within approximately one to five years. An empirical attenuation rate evaluation for molybdenum at monitoring well ALF-208, considering uncertainties, resulted in an estimate that the molybdenum concentration at downgradient well ALF-208 will decline below the GWPS within seven to 15 years. Continued groundwater monitoring and data evaluation, given the limited data set available post-CCR material removal, will refine and enhance the attenuation rate calculations for all wells at the former WADA.

3.4 TIER III DETERMINE SYSTEM CAPACITY AND EVALUATE STABILITY OF ATTENUATION

The objective of Tier III is to determine if the aquifer has the capacity to attenuate the target constituent and to determine if the immobilized constituent is stable. To determine the attenuation capacity and stability of the system, evaluations of the mass flux of arsenic and molybdenum in groundwater, the total potential capacity of the subsurface for attenuation, and geochemical constraints on attenuation (i.e., pH) must be completed. At this time, additional post-CCR removal groundwater sampling and geochemical data are needed to support the evaluation of arsenic and molybdenum attenuation capacity and stability in the Alluvial aquifer.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Monitored Natural Attenuation Assessment
October 30, 2025

3.5 TIER IV – DESIGN PERFORMANCE MONITORING

The objective of Tier IV is to establish a Performance Monitoring Plan to assess the long-term performance of MNA. At the ALF Plant, groundwater samples are collected quarterly from onsite monitoring wells in accordance with the TDEC-approved groundwater monitoring plan (Stantec 2024). A performance monitoring plan would be developed if additional groundwater and geochemical data collection and evaluation demonstrate that MNA will be an effective corrective measure, and MNA becomes the corrective action for the former WADA.



Overall Summary and Conclusion
October 30, 2025

4.0 OVERALL SUMMARY AND CONCLUSION

This MNA Evaluation TM was prepared in general concordance with the USEPA Guidance (2015) on the *“Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites”* to assess the geochemical and hydrogeologic conditions affecting the concentration of arsenic and molybdenum in groundwater at monitoring wells ALF-207A, ALF-207B, ALF-208, ALF-208B, ALF-219B, and ALF-220B. This analysis was undertaken to evaluate if conditions within the unconsolidated materials through which groundwater flows are sufficient to support MNA as a corrective action for arsenic and molybdenum.

While a steady-state hydraulic condition has yet to be achieved in the Alluvial aquifer following the former removal of CCR material from the former WADA, subsequent data suggests reduced CCR material-related influence on downgradient former WADA monitoring wells. Geochemical data indicate that the unconsolidated materials of the Alluvial aquifer may exhibit attenuation mechanisms and capacity supportive of MNA as a corrective action.

The findings of the tiered evaluation are summarized as follows:

- **Tier I – Plume Stability**

Arsenic and molybdenum concentrations in the former WADA downgradient groundwater are stable, if not decreasing. The region of downgradient groundwater with arsenic and molybdenum concentrations above GWPS appears to be (1) not expanding or migrating (i.e., limited to well ALF-207 and ALF208 series wells); and (2) subject to natural attenuation mechanisms.

- **Tier II – Mechanism and Rate of Attenuation**

The principal mechanism of attenuation is likely adsorption of arsenic and molybdenum to secondary iron hydroxide minerals associated with the unconsolidated materials. An empirical attenuation rate analysis concluded that, considering uncertainties, the arsenic concentration at downgradient well ALF-208 is anticipated to fall below the 10 µg/L GWPS within approximately the next one to five years. For molybdenum, and molybdenum concentrations are expected to decrease to GWPS within seven to 15 years. These attenuation time frames are based on limited post-CCR removal data, and for some specific monitoring wells, and calculation of an attenuation rate was not possible at this time. Attenuation rates will be further refined with continued sampling and data evaluation.

- **Tier III – System Capacity and Stability of Attenuation**

The long-term stability of the arsenic and molybdenum attenuation mechanism could not be evaluated using the current post-CCR removal dataset.

- **Tier IV – Performance Monitoring**

Given the small number of data points available post-CCR material removal and closure at the former WADA monitoring wells, performance monitoring is a key component of this MNA evaluation. It is anticipated that with continued monitoring, the evaluation presented in this TM will be bolstered by the additional data, thereby refining, and enhancing, the details of plume stability, attenuation mechanisms and accuracy of calculated attenuation rates.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

Overall Summary and Conclusion
October 30, 2025

Since the removal of CCR material, changes in concentrations of CCR constituents in groundwater at the former WADA have occurred, and it is likely that groundwater quality will improve over time due to natural processes. This initial evaluation indicates that MNA could be an effective corrective action for groundwater, but there are currently insufficient post-removal groundwater data to support a complete MNA evaluation. TVA will continue to perform routine groundwater monitoring at the former WADA and plans to collect additional geochemical data over the next two to three years. If future data and evaluations confirm that MNA will be effective, then TVA will coordinate with and obtain approval from TDEC to implement MNA as the corrective action.



APPENDIX C - MONITORED NATURAL ATTENUATION EVALUATION TECHNICAL MEMORANDUM

References

October 30, 2025

5.0 References

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TABLES

Table 1 Soil Geochemistry Boreholes and Sample Depths

Borehole	Sample Date	Start Depth (ft bgs)	End Depth (ft bgs)
ALF-220A	10/10/2022	45.0	46.0
		69.5	70.5
		94.5	95.5
		119.5	120.5
		140	141.0
ALF-221	9/30/2022	39.5	40.5
		69.5	70.5
		94.5	95.5
		119.5	120.5
		144.5	145.5
ALF-222A	10/1/2022	48.0	49.0
		77.5	78.5
		101.5	102.5
		127.5	128.5
		154.5	155.5

ft bgs = feet below ground surface

Table 2 Minerals Identified by XRD

Sample ID	Mineral Phase (percent, %)																		
Sample Name	Albite	Ankerite	Amorphous	Anorthoclase	Apatite	Calcite	Chlorite	Clay	Dolomite	Gibbsite	Gypsum/Anhydrite	Illite/Mica	Magnetite	Microcline	Orthoclase	Plagioclase	Pyrite	Siderite	Quartz
ALF-220A-45.0/46.0	14	<0.5	<10	<0.5	<0.5	<0.5	4	<0.5	3	<0.5	<0.5	11	<0.5	11	<0.5	<0.5	<0.5	<0.5	57
ALF-220A-69.5/70.5	9	<0.5	<10	<0.5	<0.5	<0.5	2	<0.5	1	<0.5	<0.5	2	<0.5	15	<0.5	<0.5	<0.5	<0.5	71
ALF-220A-94.5/95.5	12	<0.5	<10	<0.5	<0.5	<0.5	1	<0.5	1	<0.5	<0.5	5	<0.5	16	<0.5	<0.5	<0.5	<0.5	64
ALF-220A-119.5/120.5	8	<0.5	<10	<0.5	<0.5	<0.5	1	<0.5	<1.0	<0.5	<0.5	1	<0.5	15	<0.5	<0.5	<0.5	<0.5	75
ALF-220A-140.0/141.0	8	<0.5	<10	<0.5	<0.5	<0.5	2	<0.5	1	<0.5	<0.5	2	<0.5	16	<0.5	<0.5	<0.5	<0.5	71
ALF-221-39.5/40.5	13	<0.5	<10	<0.5	<0.5	<0.5	4	<0.5	2	<0.5	<0.5	5	<0.5	12	<0.5	<0.5	<0.5	<0.5	65
ALF-221-69.5/70.5	12	<0.5	<10	<0.5	<0.5	<0.5	5	<0.5	2	<0.5	<0.5	6	<0.5	11	<0.5	<0.5	<0.5	<0.5	66
ALF-221-94.5/95.5	13	<0.5	<10	<0.5	<0.5	<0.5	3	<0.5	1	<0.5	<0.5	4	<0.5	10	<0.5	<0.5	<0.5	<0.5	70
ALF-221-119.5/120.5	10	<0.5	<10	<0.5	<0.5	<0.5	4	<0.5	<1.0	<0.5	<0.5	1	<0.5	10	<0.5	<0.5	<0.5	<0.5	76
ALF-221-144.5/145.5	8	<0.5	<10	<0.5	<0.5	<0.5	1	<0.5	1	<0.5	<0.5	3	<0.5	10	<0.5	<0.5	<0.5	<0.5	78
ALF-222A-48.0/49.0	11	<0.5	<10	<0.5	<0.5	<0.5	3	<0.5	1	<0.5	<0.5	6	<0.5	11	<0.5	<0.5	<0.5	<0.5	68
ALF-222A-77.5/78.5	12	<0.5	<10	<0.5	<0.5	<0.5	3	<0.5	1	<0.5	<0.5	5	<0.5	11	<0.5	<0.5	<0.5	<0.5	69
ALF-222A-101.5/102.5	10	<0.5	<10	<0.5	<0.5	<0.5	2	<0.5	<1.0	<0.5	<0.5	4	<0.5	11	<0.5	<0.5	<0.5	<0.5	75
ALF-222A-127.5/128.5	10	<0.5	<10	<0.5	<0.5	<0.5	1	<0.5	<1.0	<0.5	<0.5	3	<0.5	10	<0.5	<0.5	<0.5	<0.5	77
ALF-222A-154.5/155.5	10	<0.5	<10	<0.5	<0.5	<0.5	2	<0.5	1	<0.5	<0.5	2	<0.5	9	<0.5	<0.5	<0.5	<0.5	79

< = The result was less than the indicated reporting limit.

Table 3 Non-Crystalline and Metal Hydroxide Sequential Extraction (SEP) Data for Iron and Arsenic

Sample ID	Iron (mg/kg)			Aluminum (mg/kg)			Arsenic (mg/kg)		
	Non-Crystalline	Metal Hydroxide	Combined	Non-Crystalline	Metal Hydroxide	Combined	Non-Crystalline	Metal Hydroxide	Combined
ALF-220A-45.0/46.0	1720	2880	4600	162	1280	1442	0.986	0.981 U	N/A
ALF-220A-69.5/70.5	924	1600	2524	71.4	563	634	0.456 J	0.711 U	N/A
ALF-220A-94.5/95.5	1750	2040	3790	113	670	783	0.654	0.980 U	N/A
ALF-220A-119.5/120.5	3580	1520	5100	48.5	328	377	0.281 J	0.554 U	N/A
ALF-220A-140.0/141.0	2220	1480	3700	63.4	381	444	0.341 J	0.818 U	N/A
ALF-221-39.5/40.5	601	2880	3481	93.2	759	852	0.839	1.38 U	N/A
ALF-221-69.5/70.5	1460	2460	3920	101	1050	1151	0.965	1.06 U	N/A
ALF-221-94.5/95.5	616	1800	2416	52	614	666	0.307 J	0.878 U	N/A
ALF-221-119.5/120.5	770	1250	2020	26.7	267	294	0.525 J	0.793 U	N/A
ALF-221-144.5/145.5	1300	1280	2580	39.5	307	347	0.696	0.696 U	N/A
ALF-222A-48.0/49.0	948	2080	3028	103	818	921	0.685	0.852 U	N/A
ALF-222A-77.5/78.5	1200	1860	3060	104	725	829	0.588	0.903 U	N/A
ALF-222A-101.5/102.5	491	1370	1861	44.4	393	437	0.338 J	0.597 U	N/A
ALF-222A-127.5/128.5	887	1600	2487	77.2	347	424	0.915	1.05 U	N/A
ALF-222A-154.5/155.5	5050	1500	6550	76.5	317	394	0.946	0.990 U	N/A

Notes:

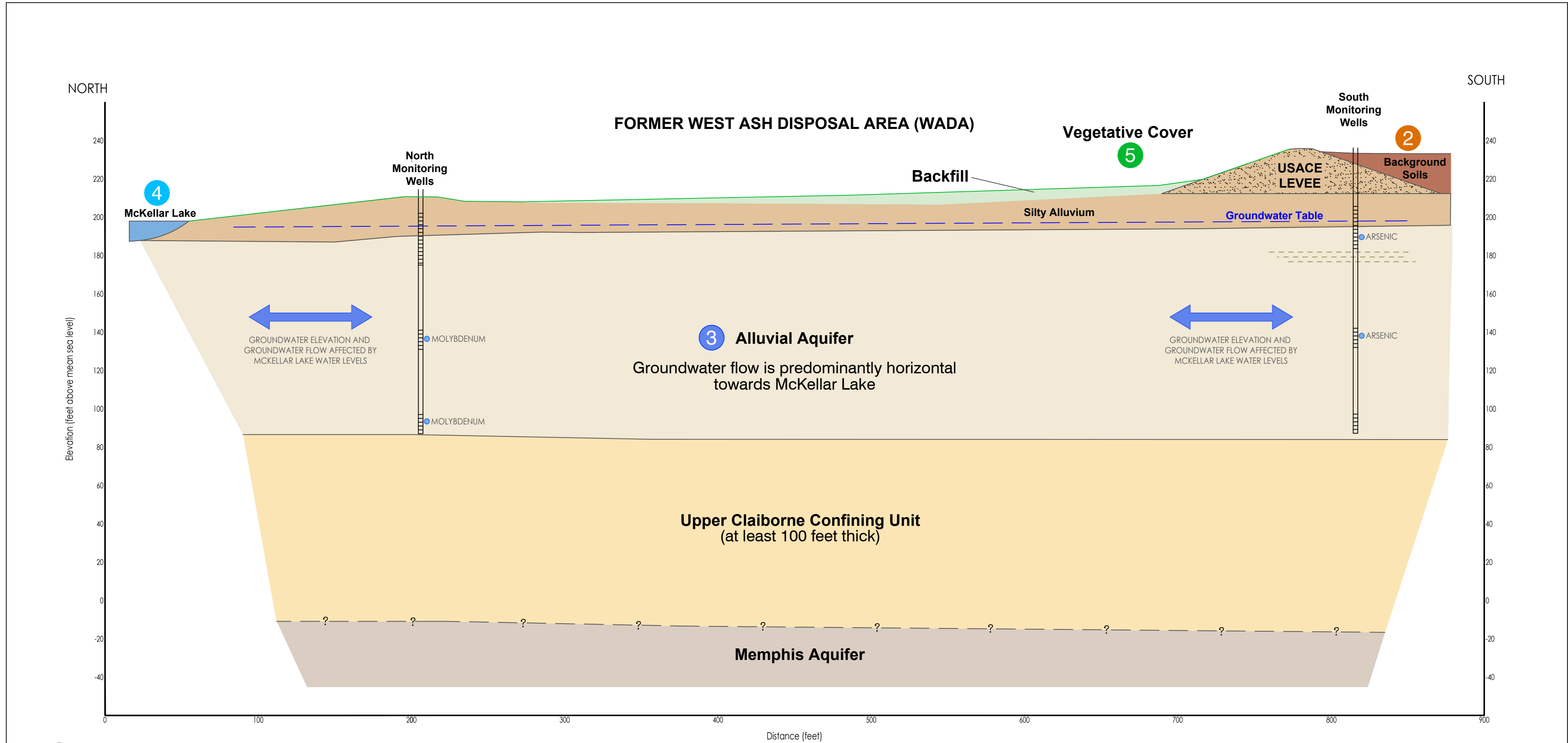
J = The result is an estimated value.

U = The analyte was not detected above the indicated reporting limit.

N/A = The combined concentration was not calculated due to non-detect values.

mg/kg = milligrams per kilogram

EXHIBITS



1 CCR Material:

- CCR material has been removed from the former WADA and the area graded with clean backfill.

2 Soil:

- CCR material is not present in background soils.
- Soil concentrations within the former WADA footprint after CCR material removal were consistent with background soil concentrations.

3 Groundwater Quality:

- Groundwater flow is at a low gradient and influenced by seasonal fluctuations of Mckellar Lake levels.
- The following CCR constituents have been detected at concentrations statistically above screening levels: arsenic, and molybdenum. Most were present along the north side of the former WADA (i.e., ALF-207 and ALF-208 well clusters).
- Groundwater conditions near the former WADA will be further evaluated prior to the developing the Corrective Action / Risk Assessment (CARA) Plan.

4 Surface Water:

- Mckellar Lake has been impacted by industrial activities within the area not related to the former WADA.
- During the EI, no active seeps or areas of interest were observed onsite.

5 Ecology:

- The ALF Plant is located within a developed industrial park.
- The former WADA is covered with sod and is not expected to routinely support unique or rare wildlife species.

Legend

Vegetative cover (mowed turf grass)	Background Soils	Alluvial Aquifer	Elevation of well screened intervals (screens of well sets are depicted in a single column, but are actually closely spaced and separate well installations)
Clean Backfill	USACE Levee (native soil)	Upper Claiborne Confining Unit	Approximate Groundwater Table Surface
Alluvial Clay	Silty Alluvium	Memphis Aquifer	Generalized groundwater flow direction

Exhibit No.
2

Title
**WEST ASH DISPOSAL AREA
SITE CONCEPTUAL MODEL**

Client/Project
Tennessee Valley Authority
Allen Fossil Plant

Project Location
Memphis, Tennessee



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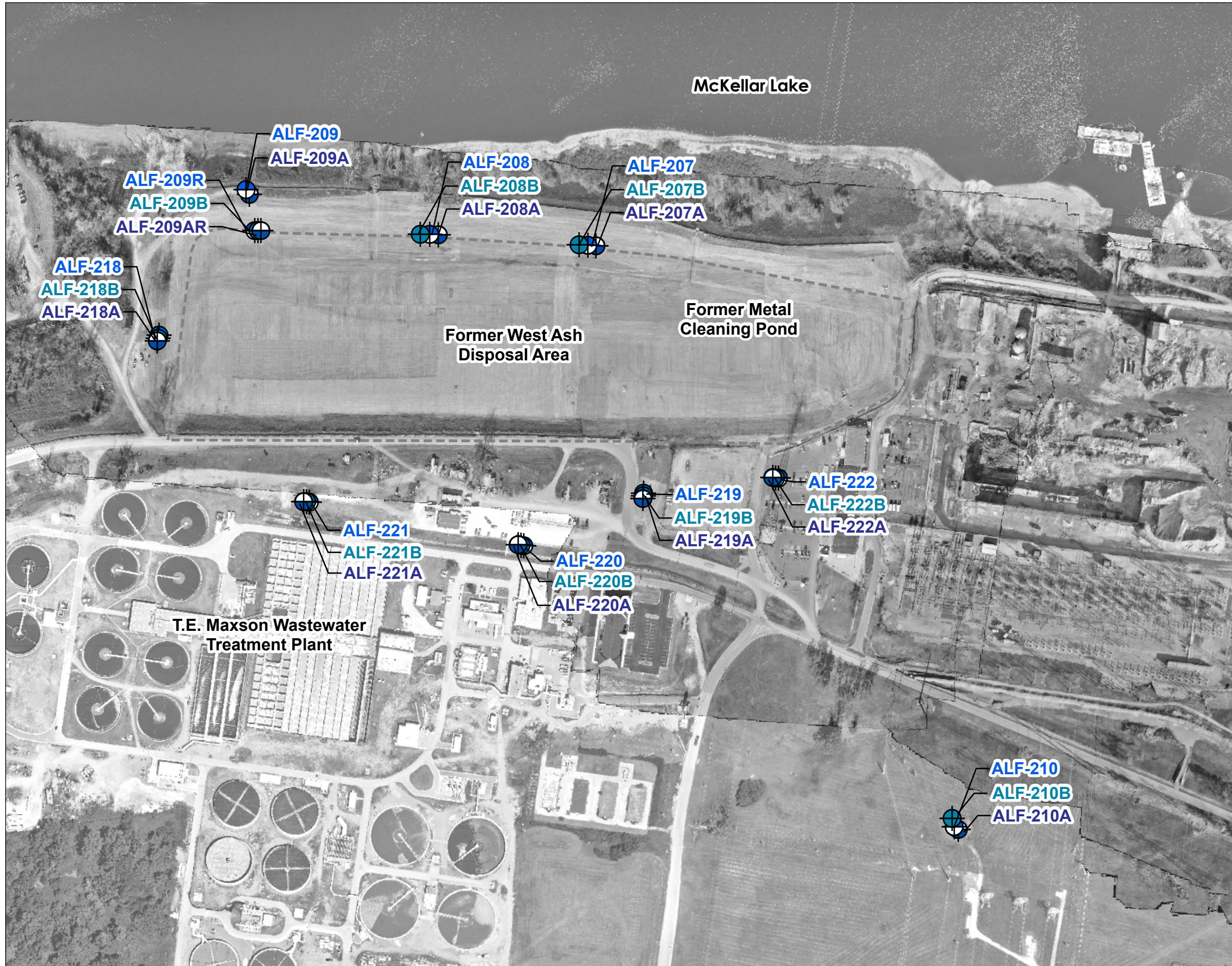
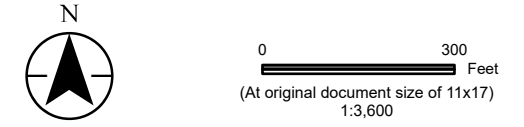


Exhibit No.
3
Title
WADA Groundwater Monitoring Network

Client/Project
Tennessee Valley Authority
Allen Fossil Plant 175568282

Project Location
Memphis, Tennessee Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02



- Legend
- Monitoring Well (Shallow)
 - Monitoring Well (Intermediate)
 - Monitoring Well (Deep)
 - Former West Ash Disposal Area

Wells are screened in the Alluvial Aquifer unless otherwise noted.

- Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
 2. Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



Exhibit 4a

WADA - Background Wells ACC - 3A and ACC - 5B

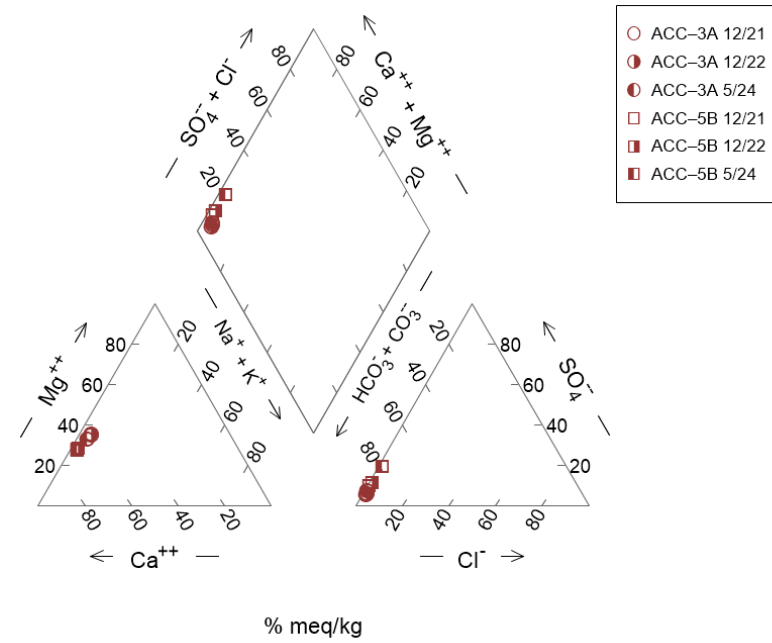


Exhibit 4b

WADA - Downgradient Well ALF - 208

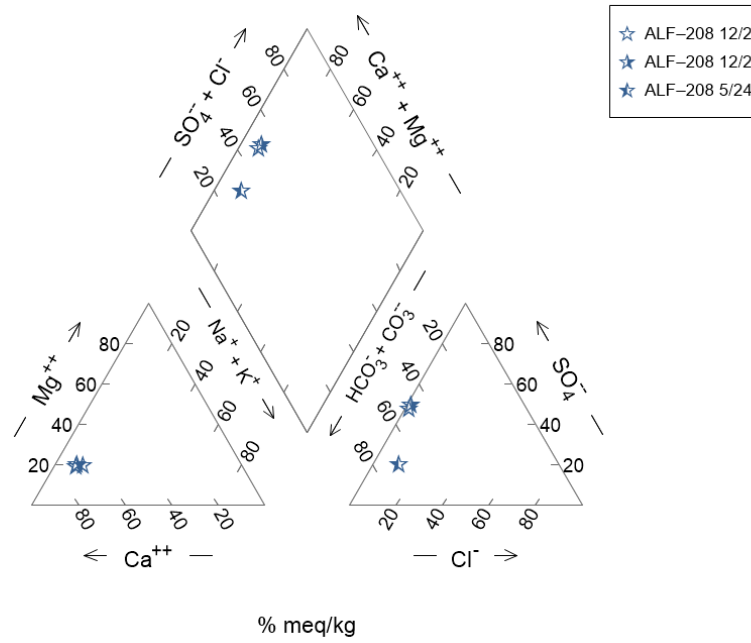


Exhibit 4c

WADA - Downgradient Well ALF - 207A

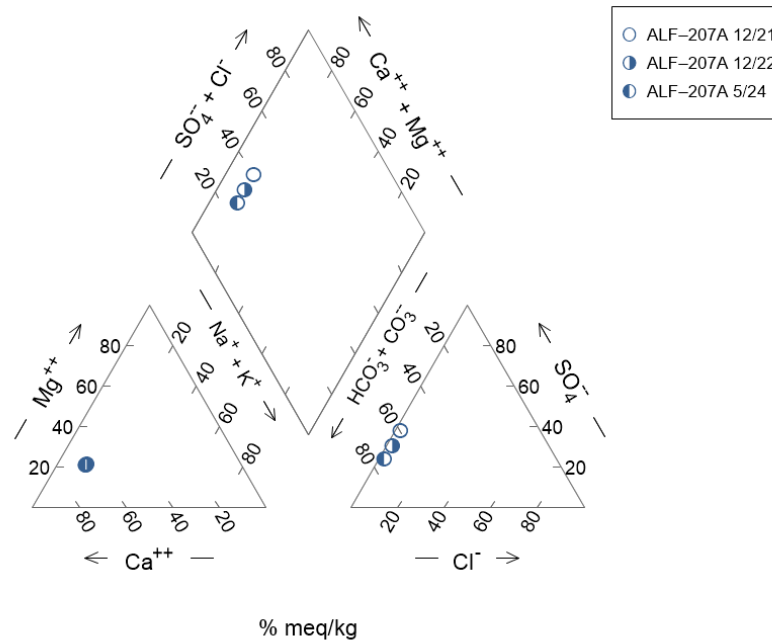


Exhibit 4d

WADA - Downgradient Well ALF - 207B

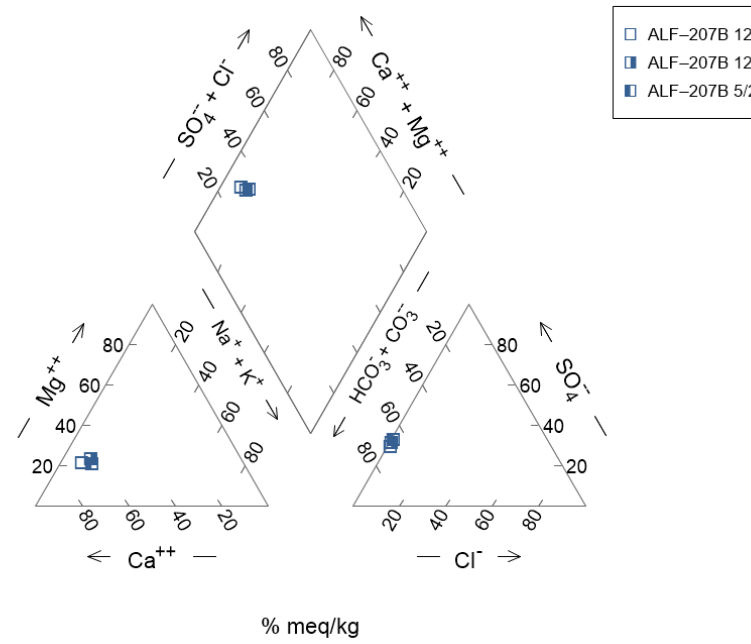


Exhibit No.

4a-d

Title

Piper Diagrams

Client/Project

Tennessee Valley Authority
Allen Fossil Plant

175568282

Project Location
Memphis, Tennessee

Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

meq/kg - milli-equivalents per kilogram

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



WADA Arsenic Time Series

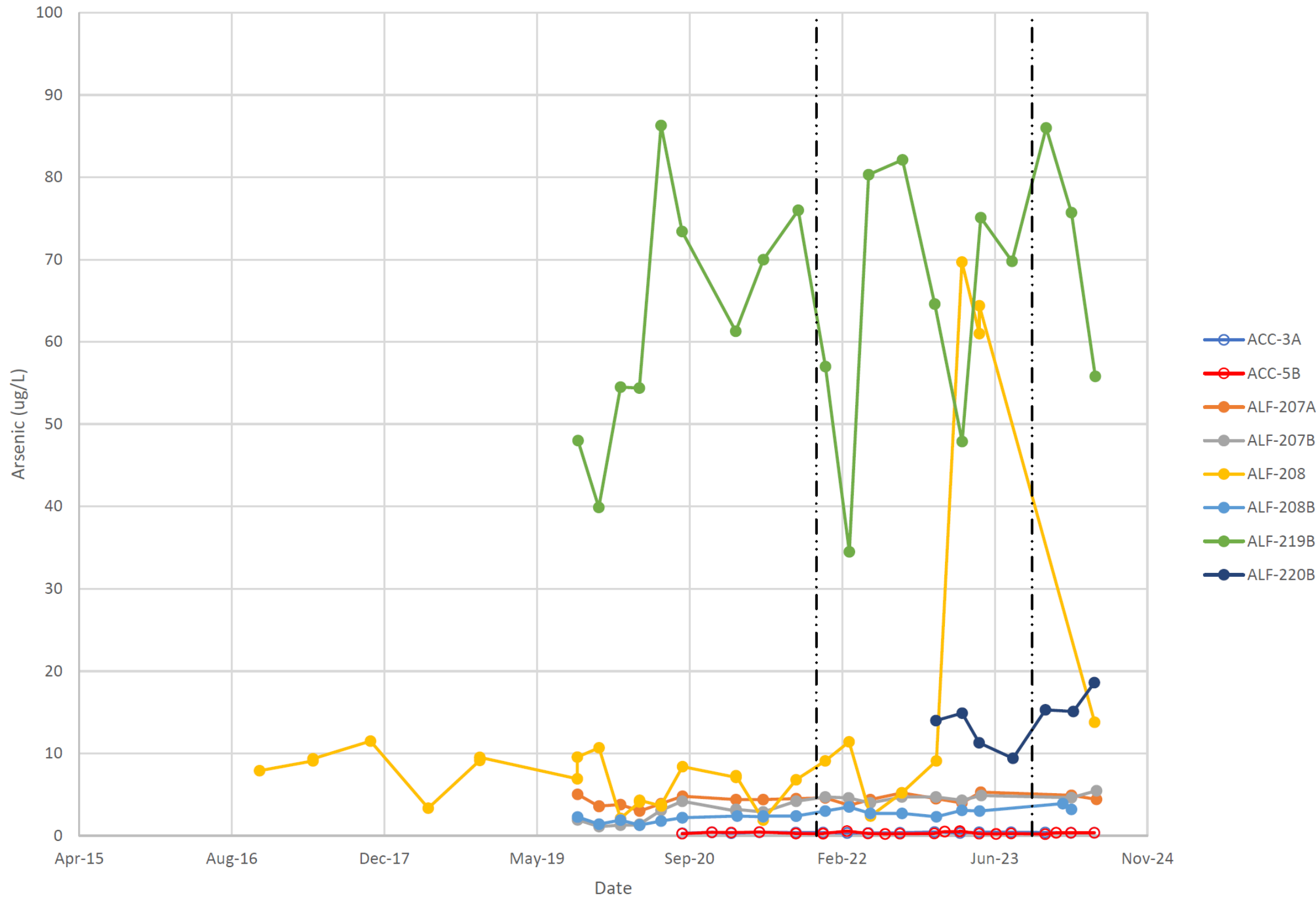


Exhibit No. **5**

Title **Time Series of Arsenic Concentrations in West Ash Disposal Area Monitoring Wells**

Client/Project Tennessee Valley Authority
Allen Fossil Plant 175568282

Project Location Memphis, Tennessee Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend
 µg/L – micrograms per liter

Notes

- Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
- Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



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WADA Molybdenum Time Series

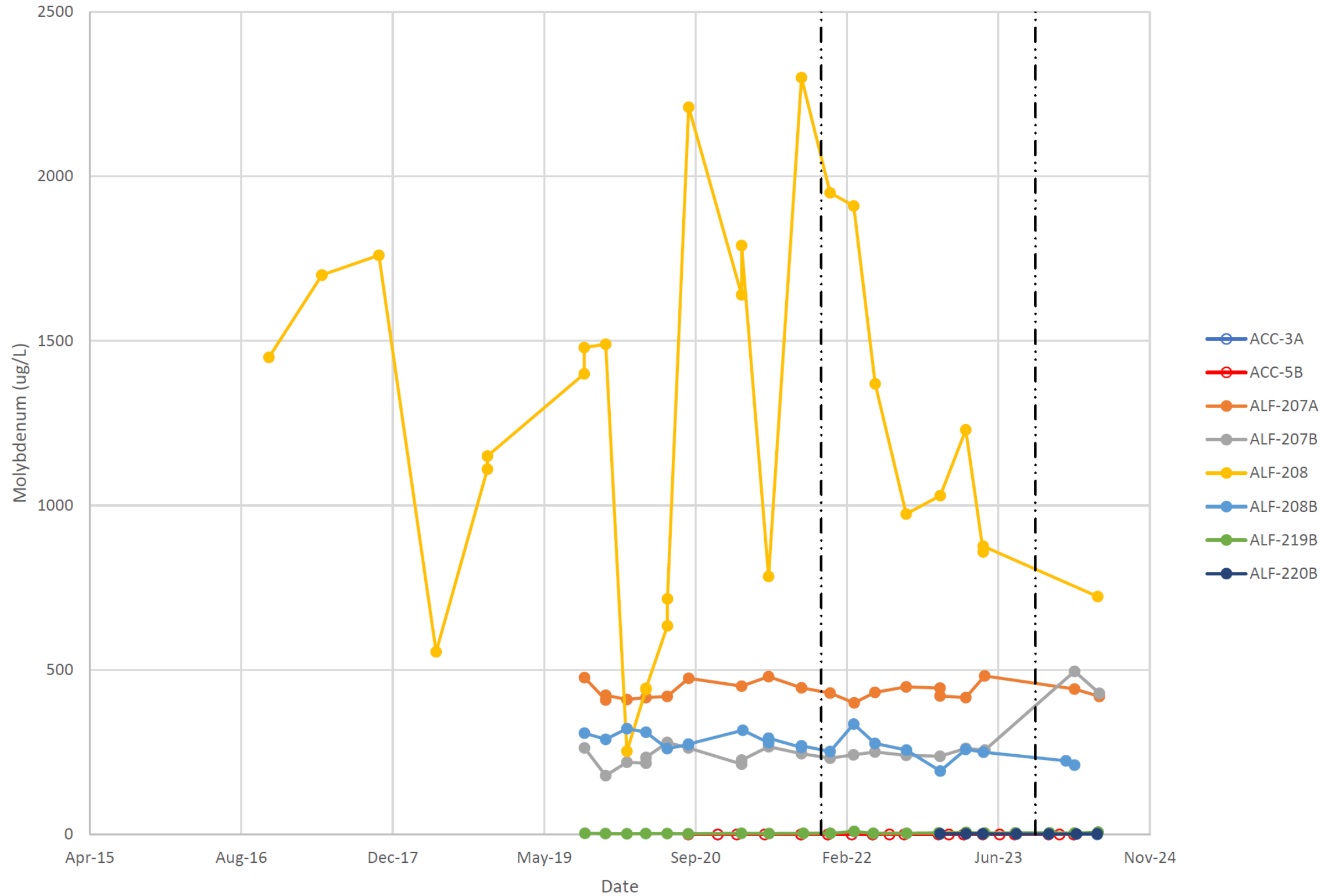


Exhibit No. **6**
Title
Time Series of Molybdenum Concentrations in West Ash Disposal Area Monitoring Wells
Client/Project
 Tennessee Valley Authority
 Allen Fossil Plant
 175568282
Project Location
 Memphis, Tennessee
 Prepared by DMB on 2024-07-02
 Technical Review by BT on 2024-07-02

Legend
 ug/L – micrograms per liter

- ACC-3A
- ACC-5B
- ALF-207A
- ALF-207B
- ALF-208
- ALF-208B
- ALF-219B
- ALF-220B

Notes
 1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
 2. Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



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ALF-208 Arsenic and Molybdenum Time Series

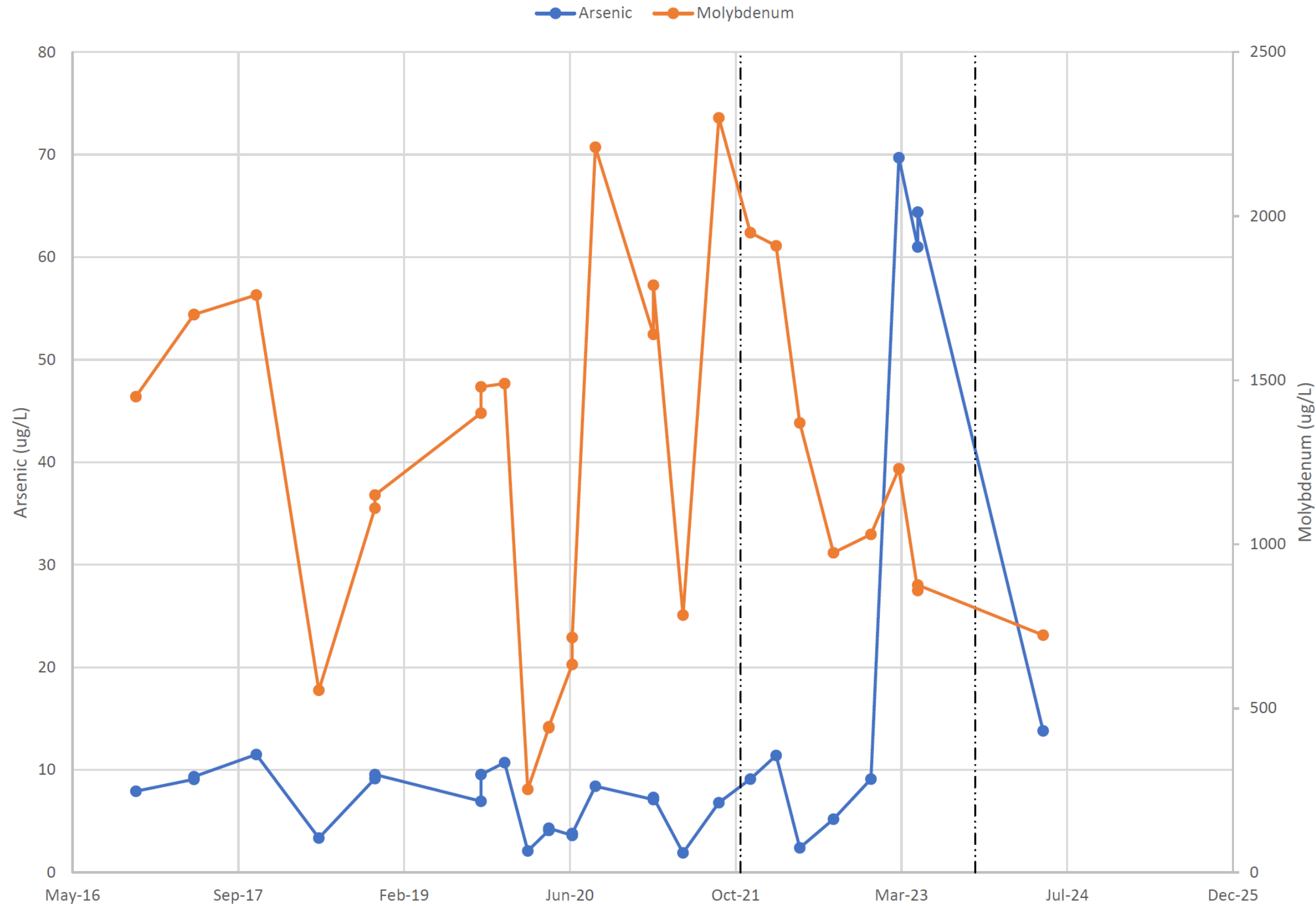


Exhibit No. **7**

Title
Time Series of Arsenic and Molybdenum Concentrations at ALF-208

Client/Project
Tennessee Valley Authority
Allen Fossil Plant

Project Location
Memphis, Tennessee

175568282

Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend
µg/L – micrograms per liter



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ALF-208 pH and Eh Time Series

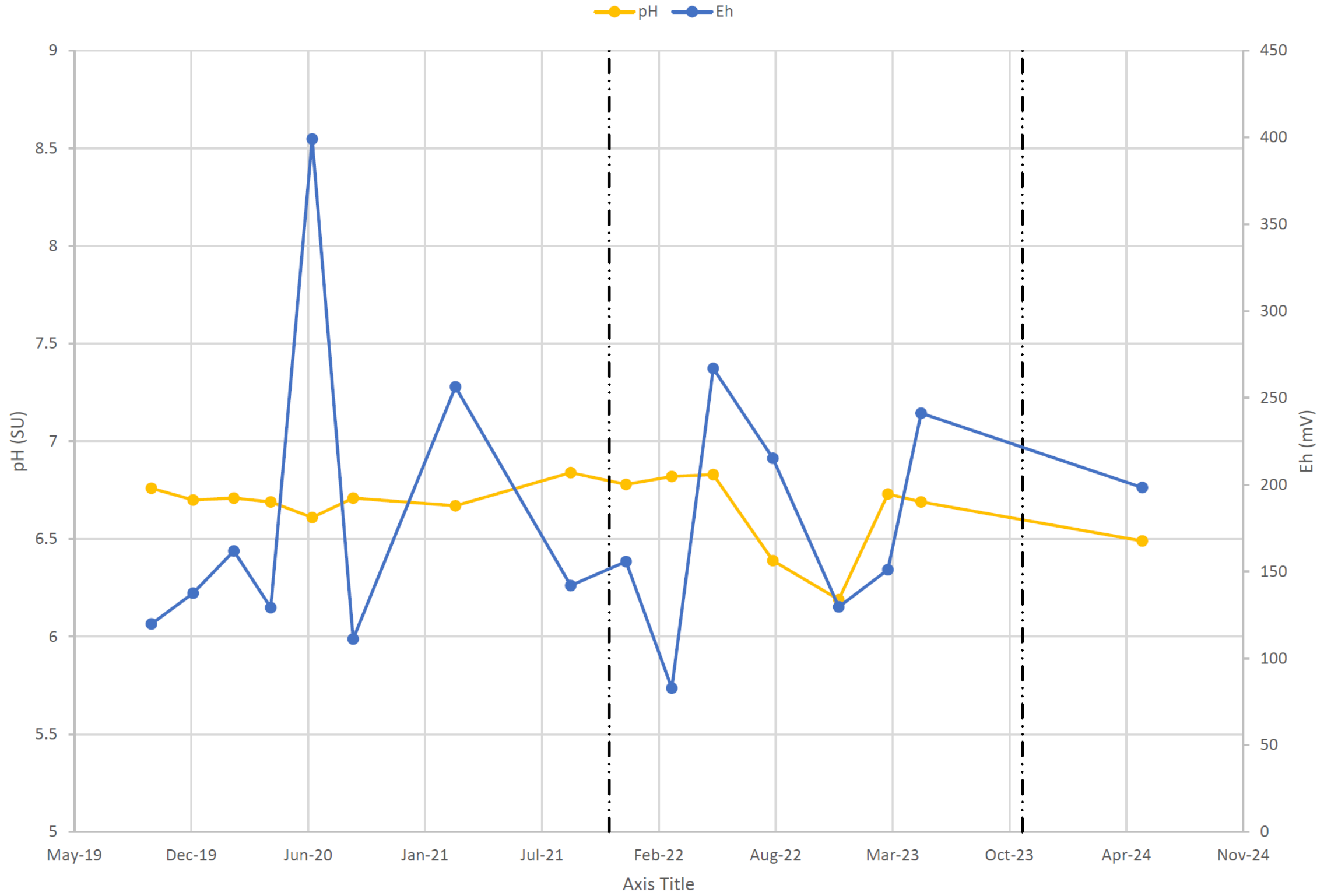


Exhibit No.
8

Title
Time Series of pH and Eh at ALF-208

Client/Project
Tennessee Valley Authority
Allen Fossil Plant

175568282

Project Location
Memphis, Tennessee

Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend
SU - standard units
mV - milivolts



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ALF-208 Sulfate Time Series

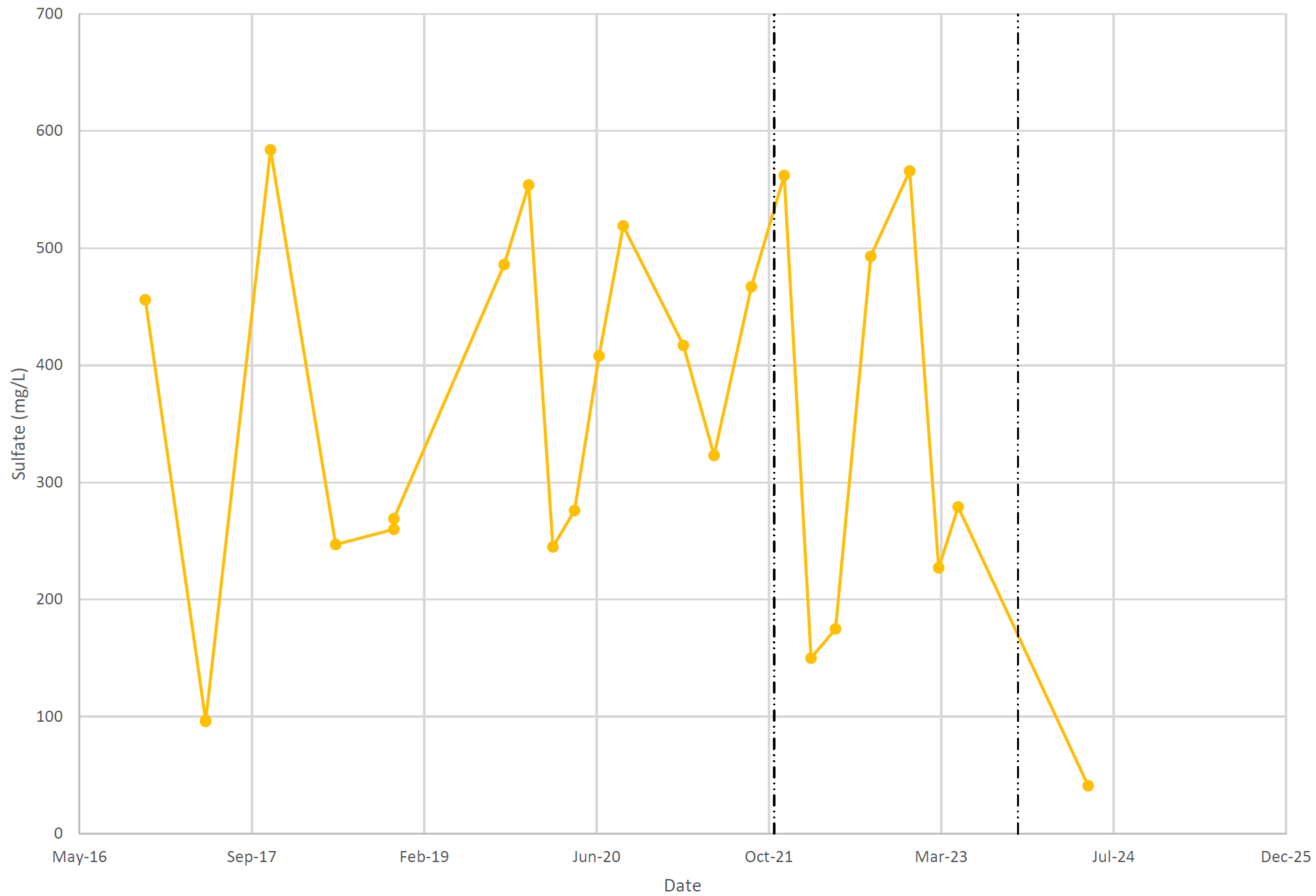


Exhibit No.

9

Title

Time Series of Sulfate at ALF-208

Client/Project
Tennessee Valley Authority
Allen Fossil Plant

175568282

Project Location
Memphis, Tennessee

Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend

mg/L - milligrams per liter

Notes

- Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
- Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



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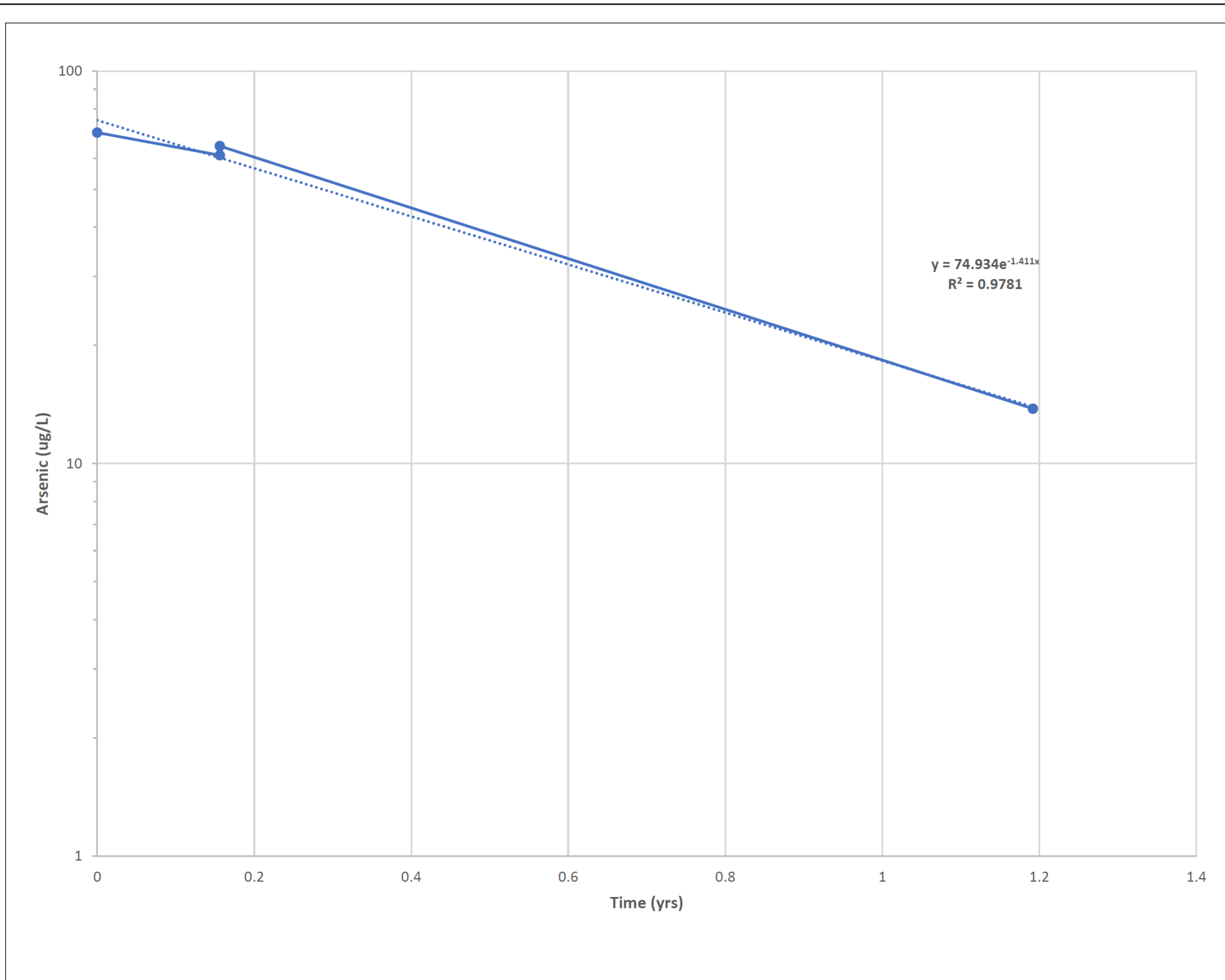


Exhibit No. **10**

Title
Empirical Attenuation Rate of Arsenic at ALF-208

Client/Project
Tennessee Valley Authority
Allen Fossil Plant 175568282

Project Location
Memphis, Tennessee Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend
yrs - years
µg/L – micrograms per liter

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)



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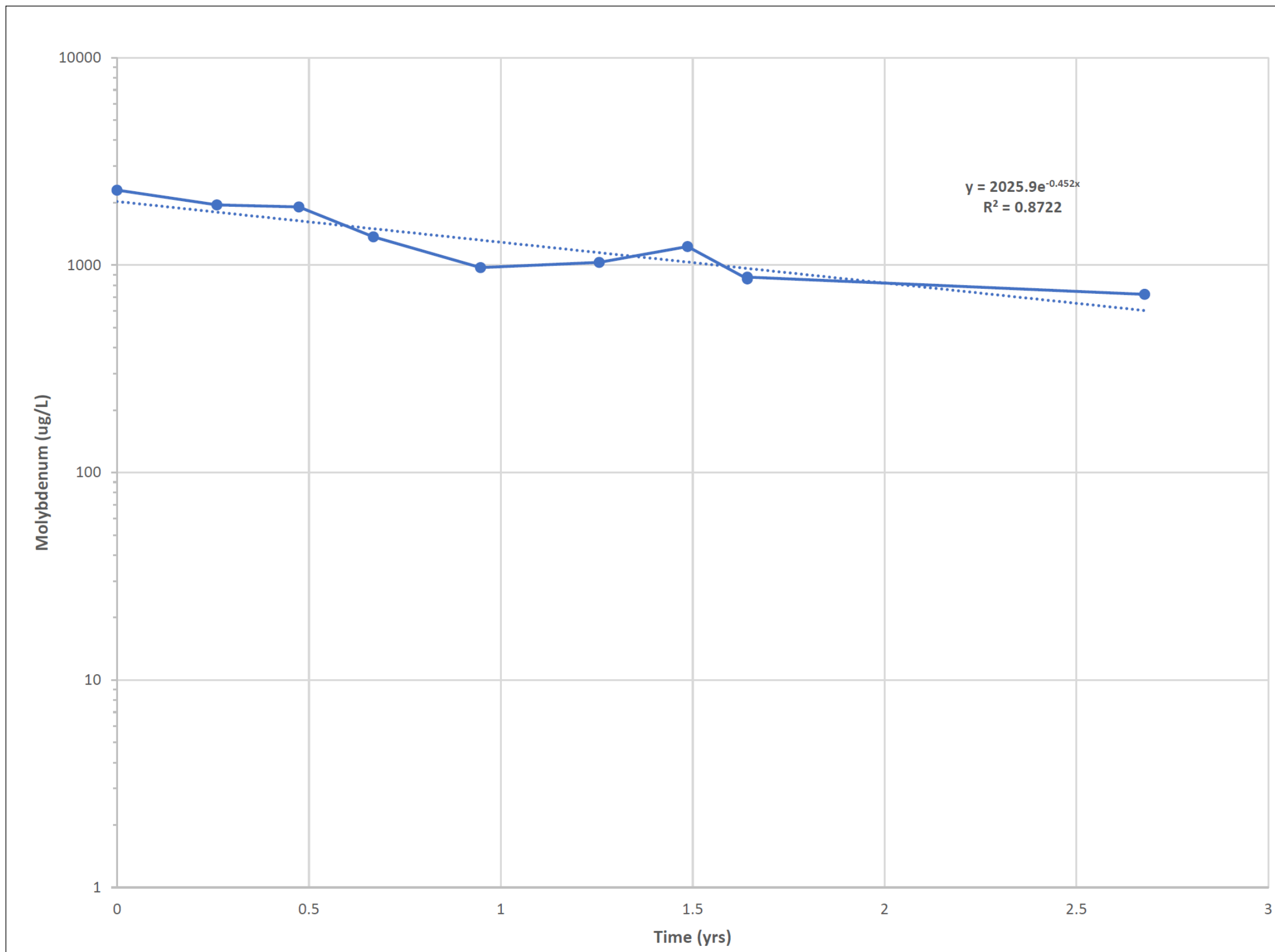


Exhibit No.
11

Title
Empirical Attenuation Rate of Molybdenum at ALF-208

Client/Project
Tennessee Valley Authority
Allen Fossil Plant

175568282

Project Location
Memphis, Tennessee

Prepared by DMB on 2024-07-02
Technical Review by BT on 2024-07-02

Legend
yrs - years
µg/L – micrograms per liter

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Kiewit (10/26/2023 and 12/6/2023) and TVA (2023)

