2019 ANNUAL CCR RULE GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

McELROY'S RUN COAL COMBUSTION BYPRODUCT DISPOSAL FACILITY

Pleasants Power Station
Pleasants County, West Virginia

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Tetra Tech Project No. 212C-SW-00070

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1.0 INTRODUCTION

This 2019 Annual Coal Combustion Residuals (CCR) Groundwater Monitoring and Corrective Action Report was prepared by Tetra Tech, Inc. (Tetra Tech) on behalf of FirstEnergy (FE), for the McElroy's Run Coal Combustion Byproduct Disposal Facility (CCBDF or "CCR units") at the Pleasants Power Station (hereinafter referred to as the "Station"). The Station is located in Pleasants County, West Virginia. This report was developed to comply with the requirements of § 257.90(e) of the federal CCR Rule (40 CFR, Part 257, Subpart D).

1.1 BACKGROUND AND SITE CHARACTERISTICS

CCRs produced at the Station are placed in the facility's captive CCBDF, which is located approximately one mile east-southeast of the Station. The facility consists of both a wet disposal area (impoundment) and dry disposal area (landfill) developed in the McElroy's Run watershed. Taken together, the landfill and impoundment are regulated under West Virginia Department of Environmental Protection (WVDEP) Solid Waste/National Pollutant Discharge Elimination System (NPDES) Water Pollution Control Permit No. WV0079171 and the CCR Rule. A WVDEP groundwater monitoring program for the facility has been in effect since 1994 and a separate CCR Rule groundwater monitoring program has been in effect since 2017. As per the CCR Rule, the landfill and impoundment are considered two separate, existing CCR units that share a common boundary (the impoundment dam). As provided by the CCR Rule, a multiunit groundwater monitoring system has been established for the CCBDF.

The impoundment is situated in the upper portion of the watershed, is unlined, and has been in continuous use since the late 1970s. The landfill is situated in the lower portion of the watershed (adjacent to and overlying the impoundment dam), is lined, and has been in continuous use since the early 1990s. At the current water level, the surface impoundment area is approximately 250 acres. The impoundment dam was constructed with a clay-filled cutoff trench at the upstream toe and with a clay blanket on the upstream face for a low permeability seepage barrier. The downstream portion of the dam was constructed using compacted fly ash and intermittent layers of bottom ash for blanket drains connected to sloping chimney drains that collect and convey seepage to discharge pipes for monitoring. The downstream face of the dam is covered by the landfill facility which WVDEP considers to be a buttress for the dam.

The landfill consists of three primary development stages (I, II, and III in the original WVDEP permit drawings and now referred to as 1, 2, and 3) which are further subdivided into construction subareas (e.g., Stage 1G, 2A, etc.). At this time, development and disposal operations have only been performed in the Stage 1 and 2 areas while the Stage 3 area remains undeveloped. Up until 2009, all the landfill subareas were constructed with a compacted clay liner system that included an underlying combined groundwater underdrain/leak detection system and overlying leachate collection system. However, since 2009 (in subareas 1G and 2B), a composite geosynthetic liner system (geosynthetic clay liner and geomembrane) has been utilized that also includes an underlying combined groundwater underdrain/leak detection system and overlying leachate collection system. For all portions of the landfill that overlie the downstream face of the impoundment dam, a bottom ash blanket drain layer has also been installed beneath the liner system. Leachate and contact stormwater runoff from the Stage 1 and 2 disposal areas are managed in Sedimentation Pond Nos. 1 and 2, which are lined impoundments located immediately down-valley of the future Stage 3 landfill development area.

Groundwater in the CCBDF area occurs primarily within fractured bedrock, principally in the following sandstone units (listed in descending order): the Morgantown sandstone, Grafton sandstone, Jane Lew sandstone, and the Saltsburg sandstone. Groundwater has also been identified in the Ames limestone and Harlem Coal (in association with the Jane Lew sandstone), and, to a lesser extent, the redbed units at the site. Generally, the fine-grained rock units (e.g., redbeds) typically serve as aquitards to limit vertical groundwater migration, while the coarser grained rock units (e.g., sandstones) typically have more well-developed and open fracture systems and are the primary conduits for groundwater migration. The fractured bedrock of multiple sandstone units, including the Morgantown sandstone, Grafton sandstone, Jane Lew sandstone, and Saltsburg sandstone, has been collectively identified as the uppermost aquifer for CCR Rule groundwater monitoring for the combined landfill and impoundment CCR units.

Historic and recent groundwater level data indicate groundwater flow at the CCBDF as being primarily controlled by topography (more important for vertical migration across groundwater flow units along the valley margins near where the units outcrop) with limited, secondary control by orientation (strike and dip) of the rock units (i.e. migration down-dip within a groundwater flow unit). Groundwater has previously been interpreted to flow north from the topographically higher areas located to the south and southeast of the impoundments. However, as additional rounds of site-wide groundwater level data have been collected and evaluated, a modified interpretation of current groundwater flow patterns along the northern boundary of the site has been made and included herein. West and northwest of the impoundment dam, topography may be the dominant influence on groundwater flow, as the multiple sandstone units underlying the site are eroded and discontinuous across the valley. Groundwater flow northwest of the dam and under the landfill is in the downstream direction of McElroy's Run toward the west. Flow in all of the rock units exhibit very little seasonal and temporal fluctuations. A representative set of water level data from the current reporting period (2019) were used for contouring groundwater flow patterns at the site. A more detailed discussion of the site's geologic and hydrogeologic characteristics, including the modified interpretation along the northern site boundary, is provided in Section 2.0 of this report.

1.2 REGULATORY BASIS

As required by § 257.90(e), of the CCR Rule, Owners or Operators of existing CCR landfills and surface impoundments must prepare an Annual Groundwater Monitoring and Corrective Action Report ("AGWMCA Report") no later than January 31, 2018 and annually thereafter. According to the subject section, "For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year."

This report has been developed to meet the general requirements above and the specific requirements of § 257.90(e)(1) through (5), which include:

"(1) A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit (see Figure 2-1);

(2) Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken (see Section 2.1.1);

(3) In addition to all the monitoring data obtained under §§ 257.90 through 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs (see Sections 3.0 and 4.0 and Table 3-1);

(4) A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels) (see Section 2.3); and

(5) Other information required to be included in the annual report as specified in §§ 257.90 through 257.98 (see Sections 4.2, 4.3, and 5.0)."

In addition, the Owner or Operator must place the report in the facility's operating record as required by § 257.105(h)(1), provide notification of the report's availability to the appropriate State Director within 30 days of placement in the operating record as required by § 257.106(h)(1), and place the report on the facility's publicly accessible website, also within 30 days of placing the report in the operating record.

1.3 OVERVIEW OF REPORT CONTENTS

Section 1.0 of this report provided an overview of the CCR unit characteristics, regulatory basis, and a summary of the requirements for CCR Annual Groundwater Monitoring and Corrective Action Reports. Section 2.0 summarizes the status of key actions pertaining to CCR groundwater monitoring completed during 2019 for the CCBDF and plans for the upcoming year. Section 3.0 presents Detection Monitoring (DM) results from groundwater sampling events completed in 2019. Section 4.0 presents Assessment Monitoring (AM) results from groundwater sampling events completed in 2019 and discusses both Appendix IV Alternative Source Demonstration (ASD) activities and Nature and Extent of Release Characterization ("N&E Characterization") results from groundwater sampling events completed in 2019. Finally, Section 5.0 presents a summary of the Assessment of Corrective Measures (ACM) activities that were performed for the CCR units during 2019.

2.0 GENERAL INFORMATION

This section provides an overview of the status of the CCR groundwater monitoring program through 2019 and key activities planned for 2020.

2.1 STATUS OF THE CCR GROUNDWATER MONITORING AND CORRECTIVE ACTION PROGRAM

During calendar year 2019 (January 1st through December 31st), the following key actions were completed with regard to the CCR groundwater monitoring program for the CCBDF.

2.1.1 Groundwater Monitoring Well System

As documented in the facility's 2017 and 2018 AGWMCA Reports (accessible at http://ccrdocs.firstenergycorp.com/), the certified CCR monitoring well network consists of three upgradient (background) wells (GW-7, -21, and -22), seven downgradient wells to monitor the northern side of the combined CCR units (GW-9, -19, -20, -23, -24, -25, and -26), and three downgradient wells to monitor the western side of the combined CCR units (GW-27, -28, and -29), as summarized in attached Table 2-1 and shown on attached Figure 2-1. However, at this time, only GW-7 is being used for upgradient/background interwell comparisons based on the following:

- It was originally intended that upgradient wells GW-21 and GW-22, which are both screened in the Morgantown sandstone, would be grouped for statistical evaluation purposes. However, after both the background and the initial detection monitoring sampling events were completed, it was determined that the two wells did not have the level of statistical similarity needed for grouping and that the availability of sufficient volumes of recoverable water was a recurring problem for GW-21. As such, it was decided that only GW-22 would be used to establish background chemistry for the northern side of the CCR units since it exhibited lower concentrations of all the Appendix III parameters than those measured in GW-21 and it also provided a reliable water yield while GW-21 did not. GW-21 was left in place (i.e., it was not abandoned) and it has been sampled when sufficient volumes of recoverable water were available. GW-21's water levels have also continued to be used to verify groundwater flow patterns at the site. The current intent is to keep GW-21 as a part of the CCR monitoring network until a sufficiently sized data set can be compiled and used to determine whether or not it's statistically appropriate to group its results with the data set for GW-22.

- The groundwater levels measured throughout 2019 indicated that the wells installed along the northern CCBDF boundary had continued a downward trend that began after they were first installed in 2016 and later redeveloped in 2017, but finally appeared to stabilize. It's believed that this slow drop and stabilization of groundwater levels is attributable to the low permeability of the monitored aquifer along that side of the site. An updated evaluation of the site-wide groundwater level data resulted in a modified interpretation of groundwater flow patterns along the northern boundary of the site than were described in the 2017 and 2018 AGWMCA Reports. As shown on Figure 2-1, the current understanding is that groundwater flow beneath the CCBDF still flows north, but primarily originates from the topographically higher areas located to the south of the impoundment, with a portion flowing to the northwest and a portion flowing to the northeast. This modification to the groundwater flow pattern is such that one upgradient well, GW-7, is now considered the appropriate upgradient/background well for both the western and northern boundaries of the CCR units based on its physical position and since it exhibited lower background concentrations of all the Appendix IV parameters than those measured in GW-22 except for fluoride and lithium. As such, the AM statistical evaluations that were performed in 2019 have incorporated Upper Prediction Limits (UPLs) associated with GW-7 for both boundaries.

Other than the discussions presented above, no other changes to the monitoring well network (i.e., new wells added, or existing wells abandoned) occurred during 2019.

2.1.2 Groundwater Monitoring Plan

Consistent with the work performed and summarized in the 2017 and 2018 AGWMCA Reports, the CCR unit's Groundwater Monitoring Plan (GWMP) was followed during all 2019 field sampling and laboratory analysis activities and for statistically evaluating groundwater monitoring data developed from the CCR sampling and analysis program. No changes to the facility's GWMP occurred during 2019.

2.1.3 Background Groundwater Sampling

As documented in the 2017 and 2018 AGWMCA Reports, eight independent rounds of background groundwater samples for analyzing all Appendix III and IV parameters from each of the CCR monitoring wells were collected prior to initiating the facility's CCR Detection Monitoring program in October 2017. No modifications to this background dataset occurred during 2019.

2.1.4 Statistical Methods

As documented in the 2017 and 2018 AGWMCA Reports, the background dataset discussed in Section 2.1.3 of this Report was used to select the appropriate statistical evaluation methods for each CCR groundwater monitoring parameter to identify any Statistically Significant Increases (SSIs) over background concentrations and determine whether any concentrations were at Statistically Significant Levels (SSLs) above their respective Groundwater Protection Standards (GWPS) established for the site. These statistical methods are available on the facility's publicly accessible website and no changes were made to them during 2019.

2.2 PROBLEMS ENCOUNTERED/RESOLVED

As noted in the 2018 AGWMCA Report, having a sufficient recoverable volume of groundwater from downgradient well GW-26 continued to be a problem during sampling events AM-1 and AM-2. However, once the groundwater levels along the northern CCBDF boundary, including GW-26, were determined to have stabilized (refer to Section 2.1.1 of this Report), it was decided that the dedicated pump should be pulled from the well and have its intake depth lowered to try and take advantage of what water was available for sampling. The pump was pulled in February 2019 during the AM-3 sampling event, inspected for any maintenance issues (none were found), and a new safety cable and tubing were installed which lowered the pump intake depth by seven feet from its original setting. The pump was re-installed in April 2019 and successfully used for the AM-4 sampling event in July.

Other than the intake adjustment for GW-26 noted above, there were no other significant problems (e.g., quality control issues) encountered during 2019 with regard to the CCR groundwater monitoring program.

2.3 TRANSITION BETWEEN MONITORING PROGRAMS

As documented in the 2018 AGWMCA Report, the CCR units transitioned from Detection Monitoring to Assessment Monitoring. As part of this transition, all required notifications were issued, appropriate GWPS for Appendix IV parameters were established, and the first two AM sampling events (AM-1 and AM-2) were completed. The CCR units remained in Assessment Monitoring throughout 2019, with two additional AM sampling events completed (AM-3 and AM-4) and statistical evaluations of the AM-1, -2, and -3 sampling events being performed. As discussed in Section 4.1 of this Report, statistical evaluations of the AM-1, -2, and -3 data indicated there were SSLs in one or more well comparisons. Based on the parameters for which SSLs were identified, an Appendix IV Alternative Source Demonstration was then undertaken as discussed in Section 4.2 of this Report. However, all of the Appendix IV SSLs that were identified could not be attributed to alternative sources. As such, Nature and Extent of Release Characterization activities and an Assessment of Corrective Measures occurred and are discussed in Sections 4.3 and 5.0 of this Report, respectively.

As of December 31, 2019, the CCR units remained in Assessment Monitoring with ongoing Nature and Extent of Release Characterization and Selection of Remedy activities being performed.

2.4 KEY ACTIVITIES PLANNED FOR THE UPCOMING YEAR

The following are the key CCR groundwater compliance activities planned for 2020:

- Continue with Assessment Monitoring by conducting the annual and semi-annual rounds of sampling and analysis for applicable Appendix III and Appendix IV constituents [per 40 CFR § 257.95(f)] and evaluate the need to update the background data sets and associated UPLs.
- Complete the statistical evaluation of the AM-4 sampling event that occurred in 2019 to determine if there are any other Appendix IV constituent concentrations in the downgradient wells that are at SSLs above applicable GWPS.
- If any new SSLs are identified, provide appropriate notification [per § 257.95(g)] then potentially conduct an Appendix IV ASD [per § 257.95(g)(3)(ii)] to determine if a source other than the CCR units may be causing the new SSLs. Concurrent with undertaking an Appendix IV ASD, characterize the Nature and Extent of the new Appendix IV release and provide appropriate notification depending on the findings [per 40 CFR §§ 257.95(g)(1) and (2), respectively].
- If any new SSLs are identified and an ASD is either not undertaken, indicates that an alternative source is not responsible for all the new SSLs identified, or is not completed within 90 days of identifying there are new SSLs, then initiate and perform an Assessment of Corrective Measures for the new SSLs in accordance with 40 CFR § 257.96.
- Conduct SoR activities in compliance with 40 CFR § 257.97(a), which states that as soon as feasible after completion of the ACM, select a remedy that, at a minimum, meets the performance standards listed in 40 CFR § 257.97(b) and the evaluation factors listed in 40 CFR § 257.97(c). These activities are currently in progress and include determining current ownership of potentially affected adjacent properties, providing landowner notifications of potential impacts as per 40 CFR § 257.95(g)(2), confirming the presence

of potential downgradient domestic groundwater well receptors, and installing additional monitoring wells downgradient of the facility boundary.

- As required by 40 CFR § 257.97(d), specify, as part of the selected remedy, a schedule(s) for implementing and completing remedial activities. The schedule will require the completion of remedial activities within a reasonable period of time taking into consideration the factors set forth in 40 CFR §§ 257.97(d)(1) through (d)(6).
- As required by 40 CFR § 257.97(a), prepare a semi-annual report describing the progress in selecting and designing the remedy. The first semi-annual report will be prepared in the Spring of 2020.
- Should all required SoR activities be completed in 2020, prepare a final report describing the selected remedy. The final report will include a certification from a qualified professional engineer that the remedy selected meets the requirements of the CCR Rule selection criteria and the final report will be placed in the facility's operating record as required by § 257.105(h)(12).
- As required by 40 CFR § 257.96(e), discuss the results of the ACM at least 30 days prior to the final SoR, in a public meeting with interested and affected parties.

3.0 DETECTION MONITORING INFORMATION

3.1 GROUNDWATER ANALYTICAL RESULTS SUMMARY

As noted in Section 2.3, site-wide Assessment Monitoring was performed throughout 2019. As part of the AM program, all DM (Appendix III) parameters were also analyzed during each AM sampling event. This exceeds the requirements of 40 CFR § 257.95(d)(1) which only stipulate analyzing Appendix III parameters during every other AM sampling event.

The need to statistically analyze the 2019 Appendix III data to identify SSIs and determine if AM was necessary was precluded by the CCR units already being in AM during all of 2019, so no statistical analysis of the data was necessary. The 2019 Appendix III data that was collected and validated is presented in Table 3-1 with the intent of using it during the next update of the background dataset and associated UPLs, which will help increase the statistical power of future analyses.

4.0 ASSESSMENT MONITORING INFORMATION

4.1 GROUNDWATER ANALYTICAL RESULTS SUMMARY

In accordance with 40 CFR §§ 257.95(b) and (d)(1), the CCR groundwater sampling and analysis program implemented during 2019 consisted of two AM sampling events (AM-3 and AM-4) performed between February 5 and 25, 2019 and between July 23 and 31, 2019, respectively. For AM-3, all Appendix III and all Appendix IV constituents were analyzed while, for AM-4, analyses included all Appendix III parameters and only those Appendix IV parameters that were detected during previous AM sampling events. Laboratory analysis and validation of the sample data were completed on July 22, 2019 and January 17, 2020 for AM-3 and AM-4, respectively. Table 3-1 presents the validated analytical results for these events.

Statistical evaluations of AM data performed in 2019 included sampling events AM-1, AM-2, and AM-3. As noted in the 2018 AGWMCA Report, evaluations of data from sampling events AM-1 and AM-2 ended up being completed in January 2019 since receipt of outstanding validated results occurred late in the fourth quarter of that year. Statistical evaluation of AM-3 data was completed in August 2019 while evaluation of AM-4 data remains in-progress as of the end of the 2019 reporting period since receipt of validated AM-4 data occurred late in the fourth quarter of 2019 and a 90-day period is allowed by the CCR Rule for statistical evaluation, which falls in the first quarter of 2020. All statistical evaluation work was performed in accordance with the certified methods included in both the facility's operating record and the publicly accessible website and the results were used to determine whether there were any detected Appendix IV parameters at SSLs above the CCR unit's established GWPS. As documented in the 2018 AGWMCA Report, site-specific Appendix IV GWPS were established for the CCR units using the higher of the federal Maximum Contaminant Level (MCL) or UPL for each parameter or, for those parameters that don't have MCLs, the higher of the EPA Risk Screening Level (RSL) or the UPL. The site-specific GWPS and the results of the statistical evaluations of AM-1, -2, and -3 are presented in Tables 4-1 (northern boundary) and 4-2 (western boundary) and discussed below.

Statistical evaluation of the AM-1 and AM-2 data initially identified arsenic, barium, fluoride, lithium, and radium along the CCBDF northern boundary and arsenic along the western boundary as the parameters detected at concentrations greater than their respective GWPS. In accordance with 40 CFR § 257.106(h)(6), a notice was prepared and posted to the facility's operating record in February 2019, issued to the WVDEP, and then posted on the facility's publicly accessible website in April 2019, to provide notification of these five Appendix IV parameter SSLs at the CCR units. However, subsequent to the AM-1 and -2 statistical evaluations and as previously discussed in Section 2.1.1 of this Report, groundwater level data collected at the site necessitated a modified interpretation of current groundwater flow patterns along the northern boundary and an associated revision to the upgradient well comparisons in that area. The revised statistical evaluations determined that arsenic SSLs occurred in more wells than previously indicated but that fluoride was no longer an SSL for the single well (GW-20) in which it had originally been identified. As such, fluoride was no longer identified as an SSL at the site. During the SSL notification period and in accordance with 40 CFR § 257.95(g)(3)(ii), an Appendix IV ASD was initiated to assess the AM-1 and -2 findings (and later incorporated the AM-3 findings) and is discussed in Section 4.2 of this Report.

Results from statistical analysis of the AM-3 data were consistent with the previous AM results with respect to having SSLs for arsenic, barium, lithium, and radium along the northern boundary and arsenic along the western boundary. However, there were also first-time SSLs identified for cobalt in GW-26 and molybdenum in GW-20. The validity of these individual SSLs was questioned as, for GW-26, this was the first time a sample was able to be recovered during Assessment Monitoring and cobalt was not detected in any of the well's background sampling events, and, for GW-20, all previous background and AM sampling results were below the molybdenum GWPS. A determination as to whether or not these SSLs are anomalies will be made as part of the AM-4 statistical evaluations. If they are determined to be actionable, they will be addressed by ASD, N&E Characterization, and ACM, as applicable, in 2020.

As shown in Tables 4-1 and 4-2, to date, no other Appendix IV constituents have been detected at SSLs above the their GWPS under the CCR units' AM program.

4.2 APPENDIX IV ALTERNATIVE SOURCE DEMONSTRATION

40 CFR § 257.95(g)(3)(ii) allows the owner or operator of a CCR unit 90 days from the date of determining that an SSL has occurred to demonstrate that a source other than the CCR unit caused the SSL or that the apparent SSL was from a source other than the CCR unit or that it had resulted from errors in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Pursuant to § 257.94(g)(3)(ii), an ASD was undertaken to assess if the Appendix IV SSLs determined for AM-1, -2, and -3 were attributable to a release from the CCR units or from a demonstrable alternative source(s). A copy of the report that documents the Appendix IV ASD activities and findings is included as Attachment A of this Report and summarized below.

For the Appendix IV ASD a multiple Line of Evidence (LOE) approach was followed. This approach divides LOEs into five separate categories (types): Sampling causes (ASD Type I); Laboratory causes (ASD Type II); Statistical evaluation causes (ASD Type III); Natural variation not accounted for in the basic AM statistics (ASD Type IV); and Potential natural or anthropogenic sources (ASD Type V). As detailed in Attachment A, LOE Types I through V were assessed along with the following additional site-specific Type V LOEs: Regional groundwater chemistry studies/reports; and Potential effects of on-site and nearby oil and gas wells.

Based on the information and data included in Attachment A, the following conclusions were reached for the SSLs that were identified for the AM-1, -2, and -3 events:

- The barium and combined radium 226/228 SSLs could be attributed to historical and current oil and gas exploration and production activities that have occurred at the site and, as such, no corrective measures were required for those parameters and assessment monitoring for barium and radium should continue.
- The source of the lithium SSLs was indeterminate, but the available evidence indicates there is a high potential they are also attributable to oil and gas impacts at the site. To resolve this uncertainty, isotopic analysis and lithium sampling of well brine from on-site production equipment will be considered in 2020 and assessment monitoring of lithium should continue.
- The arsenic SSLs could not be solely attributed to sources other than the CCR units, to errors in sampling, analysis, or statistical evaluation, or from natural variation in groundwater quality.

Based on the Appendix IV ASD findings and recommendations, a transition to the applicable requirements of Assessment of Corrective Measures for arsenic per § 257.96 of the CCR Rule was determined to be warranted along with continued Assessment Monitoring of lithium to verify concentrations remain below its GWPS.

4.3 NATURE AND EXTENT OF RELEASE CHARACTERIZATION

Pursuant to 40 CFR § 257.95(g)(1), following identification of SSLs greater than their respective GWPS and concurrent with performing the Appendix IV ASD, a N&E Characterization was initiated at the site. The N&E Characterization program is discussed in detail in the ACM Report prepared for the CCR units and posted on the facility's publicly accessible website. The scope of the N&E Characterization program included the following:

- Reviewing background information on the occurrence of arsenic and fate and migration characteristics of arsenic in groundwater.

- Evaluating groundwater flow patterns at the site to establish that a combination of CCR and WVDEP groundwater monitoring program wells (GW-9, -19, -20, -23, -24, -25, and -26) fulfilled the requirement of 40 CFR § 257.95(g)(3)(iii) of having at least one monitoring well positioned at the facility boundary in the direction of contaminant migration and that installation of additional monitoring wells did not appear necessary for N&E Characterization.

- Establishing a N&E Characterization sampling and analysis program that consisted of the two regularly scheduled 2019 AM events (AM-3 and AM-4) for all of the CCR monitoring wells at the site and a third sampling event performed in July 2019 dedicated solely to N&E Characterization purposes using two WVDEP monitoring wells at the site.

- Delineating the extent of arsenic in site groundwater based on the N&E Characterization sampling and analysis program.

Final validated results for the dedicated July 2019 N&E Characterization sampling event were not available at the time the Appendix IV ASD and subsequent ACM were completed, so they are provided in Table 4-3 of this Report. The data presented in Table 4-3 indicate concentration trends similar to those found in previous sampling events and support the ASD, N&E Characterization, and ACM findings and recommendations summarized herein.

The N&E Characterization found that elevated arsenic concentrations are occurring through the impoundment and nearby adjacent areas, with the highest concentrations occurring at GW-19 (northwestern area) and GW-22 (southeastern area). Based on the interpreted distribution in groundwater, arsenic concentrations above the GWPS likely occur beyond the property boundaries to the north and southeast. In response to these findings, additional N&E Characterization work was determined to be necessary and is currently in progress. This additional work includes determining current ownership of potentially affected adjacent properties, providing landowner notifications of potential impacts as per 40 CFR § 257.95(g)(2), confirming the presence of potential downgradient domestic groundwater well receptors, and installing additional monitoring wells downgradient of the facility boundary.

Potentially impacted groundwater flows downgradient of the landfill (to the north and southeast) are expected to undergo additional attenuation based on a combination of advection, dispersion, and, potentially, natural dilution, resulting in concentrations that are anticipated to be below the arsenic GWPS before flow reaches any potential off-site groundwater receptor, with the nearest potential groundwater supply user in the downgradient flow paths being located approximately 1,500 feet from the facility boundary. However, since arsenic concentrations greater than the GWPS are likely occurring in the areas situated immediately downgradient of the facility boundary, an ACM was performed as discussed in Section 5.0 of this Report.

5.0 ASSESSMENT OF CORRECTIVE MEASURES

5.1 ACM NOTIFICATIONS

As discussed in Section 4.0, CCR Rule groundwater assessment monitoring conducted at the site identified arsenic concentrations in certain downgradient CCR monitoring wells which were at SSLs that exceeded the GWPS for arsenic, resulting in the need to conduct an Assessment of Corrective Measures per 40 CFR § 257.96. The following summarizes the notifications related to the ACM:

- On April 15, 2019, pursuant to 40 CFR §§ 257.95(g)(3)(i) and 257.105(h)(9), FE provided notification in the facility's operating record that an ACM had been initiated for arsenic in groundwater at the site. The notification was posted to the publicly accessible website on May 22, 2019.
- On July 15, 2019, pursuant to 40 CFR § 257.96(a), FE provided a demonstration in the facility's operating record that, based on hydraulic characteristics of the uppermost aquifer at the site, an additional 60 days was required to complete the ACM.
- Pursuant to 40 CFR § 257.96(d), the ACM Report was posted in the operating record and to the publicly accessible website by October 16, 2019.

5.2 ACM REPORT SUMMARY

As required by 40 CFR § 257.96(c), the ACM included an analysis of the effectiveness of potential corrective measures in meeting the remedy requirements and objectives as described under 40 CFR § 257.97. The ACM Report evaluated the following corrective measures against the referenced criteria: Source Control, Groundwater Extraction and Treatment, In-Situ Technologies and Monitored Natural Attenuation.

Based on the evaluation of viable remediation technologies, Monitored Natural Attenuation (MNA), combined with source control by the eventual installation of a final cover system, ranked highest among the evaluated options. Also, additional monitoring of the groundwater network was recommended to confirm there are not trend changes that could impact remedy effectiveness. The candidate corrective measures will be further evaluated in 2020 as part of the Selection of Remedy process discussed in Section 7.0 of the ACM Report.

TABLES

TABLE 2-1
CCR RULE GROUNDWATER MONITORING SYSTEM WELL SUMMARY
McELROY's RUN CCB DISPOSAL FACILITY – 2019 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

Well	Year Installed	Formation Monitored	Ground Surface Elevation (ft MSL)	Total Well Depth (ft bgs)	Monitored Interval (ft bgs)	Monitored Interval (ft MSL)	Casing ID and Material
Upgradient (Background)							
GW-7	1994	Grafton SS, Ames LS	918.40	101.2	75.7 – 100.7	817.70 – 842.70	4" - Sch. 40 PVC
GW-21*	2016	Morgantown SS	1033.01	234.2	214.2 – 234.2	798.77 – 818.77	2" - Sch. 40 PVC
GW-22*	2016	Morgantown SS	1045.18	370.2	350.2 – 370.2	675.02 – 695.02	2.5" - Sch. 80 PVC
Downgradient							
GW-9	1994	Ames LS, Jane Lew SS, Pittsburgh RB	797.42	177.7	137.2 – 177.2	620.22 – 660.22	4" - Sch. 40 PVC
GW-19	1995	Birmingham RB, Grafton SS, Ames LS	920.64	238.9	198.9 – 238.9	681.74 – 721.74	2" - Sch. 40 PVC
GW-20	1995	Lower Clarksburg RB	923.00	150.5	100.5 – 150.5	772.50 – 822.50	2" - Sch. 40 PVC
GW-23	2016	Grafton SS	974.40	392.9	372.9 – 392.9	581.53 – 601.53	2.5" - Sch. 80 PVC
GW-24	2016	Grafton SS	941.55	271.1	251.1 – 271.1	670.50 – 690.50	2" - Sch. 40 PVC
GW-25	2016	Grafton SS	1006.22	303.7	283.7 – 303.7	702.53 – 722.53	2" - Sch. 40 PVC
GW-26*	2016	Grafton SS	984.16	288.2	268.2 – 288.2	695.95 – 715.95	2" - Sch. 40 PVC
GW-27	2016	Saltsburg SS	675.30	48.3	38.3 – 48.3	626.96 – 636.96	2" - Sch. 40 PVC
GW-28	2016	Saltsburg SS	801.95	175.6	165.6 – 175.6	626.38 – 636.38	2" - Sch. 40 PVC
GW-29	2016	Grafton SS	928.49	166.0	156.0 – 166.0	762.45 – 772.45	2" - Sch. 40 PVC

Notes: SS = sandstone LS = limestone RB = red beds MSL = mean sea level bgs = below ground surface ID = inside diameter
PVC = polyvinyl chloride * = currently used only for water level measurements

TABLE 3-1

CCR RULE GROUNDWATER ASSESSMENT MONITORING ANALYTICAL RESULTS SUMMARY

McELROY'S RUN CCB DISPOSAL FACILITY - 2019 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

			APPENDIX III (all Chemical Constituents reported as TOTAL RECOVERABLE)[1]							APPENDIX IV (all Chemical Constituents reported as TOTAL RECOVERABLE)[1]														
SAMPLING EVENT NO.[2]	WELL ID[3]	SAMPLE DATE	BORON METALS MG/L	CALCIUM METALS MG/L	CHLORIDE MISC MG/L	FLUORIDE MISC MG/L	PH MISC S.U.	SULFATE MISC MG/L	TDS MISC MG/L	ANTIMONY METALS MG/L	ARSENIC METALS MG/L	BARIUM METALS MG/L	BERYLLIUM METALS MG/L	CADMIUM METALS MG/L	CHROMIUM METALS MG/L	COBALT METALS MG/L	LEAD METALS MG/L	LITHIUM METALS MG/L	MERCURY METALS MG/L	MOLYBDENUM METALS MG/L	SELENIUM METALS MG/L	THALLIUM METALS MG/L	RADIUM-226 RADIOCHEM PCI/L	RADIUM-228 RADIOCHEM PCI/L
13 (AM-3)	GW-7	2/19/2019	0.2946	2.54	112	8.07 J-	8.25	0.115 J	1310	0.00107 U	0.00042	0.07666	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01904	0.00016 U	0.00113 U	0.0034 U	0.00017 U	0.0695 U	0.438
14 (AM-4)	GW-7	7/23/2019	0.2817	2.94	117	8.38	8.43 J	0.121 J	1355	0.00107 U	0.0007 U	0.08553	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.0216	0.00016 U	0.00113 U	0.0068 U	0.00017 U	--	--
13 (AM-3)	GW-9	2/21/2019	0.0913 J	15.875	8	0.203 J-	7.85	123	780	0.00107 U	0.0005	0.06275	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01743	0.00016 U	0.00113 U	0.0034 U	0.00017 U	0.118 U	0.0674 U
14 (AM-4)	GW-9 (D)	7/30/2019	0.1039 J	15.028	8 J-	0.198	7.79 J	123	796	0.00107 U	0.00039	0.06203	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01581	0.00016 UJ	0.00113 U	0.0034 U	0.00017 U	--	--
14 (AM-4)	GW-9	7/30/2019	0.093 J	14.318	7.98 J-	0.199	7.85 J	123	792	0.00107 U	0.00066	0.06104	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01575	0.00016 UJ	0.00113 U	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-19	2/14/2019	0.2405	9.85	600	1.63	7.74	0.223	2413.333	0.00107 U	0.09721	1.10111	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01414	0.00016 U	0.00113 U	0.0034 U	0.00017 U	1.3	1.14
14 (AM-4)	GW-19	7/25/2019	0.2328 J+	10.261	638	1.69	7.78 J	0.0386 UJ	2480	0.00107 U	0.11223	1.23469	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01601	0.00016 U	0.00113 U	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-20	2/11/2019	0.2442	5.29	559	5.66	7.92	27.1 J-	1840	0.00107 U	0.00249	0.24056	0.00022 U	0.00067 U	0.00354	0.00058 J	0.00099	0.01607	0.00016 U	0.10255	0.00991	0.00017 U	0.273	0.232 U
14 (AM-4)	GW-20	7/24/2019	0.2771 J+	6.73	580	5.57	8.26 J	30	2375	0.00107 U	0.00253	0.22915	0.00022 U	0.00067 U	0.00197	0.00047 U	0.00052 U	0.01625	0.00016 U	0.10137	0.01529	0.00017 U	--	--
13 (AM-3)	GW-21	2/19/2019	0.144 J	7.95	656	2.57 J-	8.32	225	2360	0.00107 U	0.0168	0.11947	0.00022 U	0.00067 U	0.00584	0.00076 J	0.00052 U	0.00769	0.00016 U	0.26165	0.10061	0.00017 U	0.0758 U	0.457
14 (AM-4)	GW-21	7/23/2019	0.1436 J	10.461	691	2.57	8.4 J	237	2460	0.00107 U	0.01449	0.12625	0.00022 U	0.00067 U	0.00259	0.00047 U	0.00052 U	0.00916	0.00016 U	0.23858	0.08281	0.00017 U	--	--
13 (AM-3)	GW-22	2/25/2019	0.2029	4.75	499	2.33 J-	8.4	44 J-	1630	0.00107 U	0.16358	0.04989	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.0017	0.00591	0.00016 U	0.13215	0.0034 U	0.00017 U	0.0976 U	0.461 U
14 (AM-4)	GW-22	7/29/2019	0.2037	5.1	617	2.02	8.21 J	44.9	1760	0.00107 U	0.16488	0.06967	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00231	0.00755	0.00016 UJ	0.12276	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-23	2/7/2019	0.2161	756	12900	0.351	6.83	0.2664 J-	68500	0.00426 U	0.03247	9.76212	0.00022 U	0.0027 U	0.0058 U	0.00284	0.00052 U	0.15017	0.00016 U	0.00734	0.00068 U	0.00017 U	23.6 J	59.8 J
14 (AM-4)	GW-23	7/24/2019	1.3 J+	11.677	13700	0.025 U	7.14 J	0.372	62500	0.00533 U	0.03295	12.71739	0.0011 U	0.00337 U	0.00725 U	0.00325	0.0026 U	0.17117	0.00016 U	0.00666	0.017 U	0.00087 U	--	--
13 (AM-3)	GW-24	2/11/2019	0.3222	371	8520	0.266	6.88	0.0386 UJ	42400	0.00107 U	0.02855	9.25331	0.00022 U	0.00067 U	0.0029 U	0.00209	0.00052 U	0.04512	0.00016 U	0.00853	0.0068 U	0.00017 U	12.7 J	33.4 J
14 (AM-4)	GW-24	7/25/2019	0.2787 J+	1020	8110	1.25 U	7.06 J	0.0386 UJ	45100	0.00533 U	0.02649	12.57961	0.0011 U	0.00337 U	0.00725 U	0.00238 U	0.0026 U	0.05897	0.00016 U	0.00609	0.017 U	0.00087 U	--	--
13 (AM-3)	GW-25	2/7/2019	0.1709 J	335	7110	0.025 U	7.22	0.618	35900	0.00426 U	0.05652	7.62675	0.00025	0.0027 U	0.01045	0.00371	0.00505	0.03069	0.00016 U	0.01182	0.00068 U	0.00017 U	13.2	17.3
14 (AM-4)	GW-25	7/24/2019	0.186 J	329	7820	0.025 U	7.59 J	0.385	38100	0.00533 U	0.05792	9.75893	0.00022 U	0.00337 U	0.00915	0.00366	0.00313	0.03791	0.00016 U	0.01259	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-26	2/25/2019	0.15 U	33.509	433	1.58 J-	8.48	0.201 J-	1690	0.0107 U	0.03057	0.53473	0.00255	0.00675 U	0.0382	0.01594	0.01799	0.03863	0.00163 U	0.02644	0.034 U	0.00175 U	0.619	1.3
14 (AM-4)	GW-26	7/29/2019	0.1905 J	63.331	498	1.46	8.29 J	1.76	15500	0.00107 U	0.02522	1.33341	0.00437	0.00067 U	0.09467	0.0343	0.03931	0.08245	0.00016 UJ	0.00968	0.034 U	0.00033	--	--
13 (AM-3)	GW-27	2/5/2019	0.1046 J	55.651	128	0.305	7.56	4.25	576	0.00107 U	0.00035	0.91402	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01319	0.00016 U	0.00346	0.00068 U	0.00017 U	0.475	0.821
14 (AM-4)	GW-27	7/24/2019	0.1195 J	53.304	135	0.239	7.74 J	3.63	588	0.00107 U	0.00035 U	0.99454	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01469	0.00016 U	0.00389	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-28	2/19/2019	0.224	6.38	693	2.02	7.86	0.109 J	2220	0.00107 U	0.00554	0.24927	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01657	0.00016 U	0.0341	0.0034 U	0.00017 U	0.266	0.2 U
14 (AM-4)	GW-28	7/23/2019	0.2298	7.16	695	2.09	7.97 J	0.136 J	2280	0.00107 U	0.00458	0.26772	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.01931	0.00016 U	0.03372	0.0034 U	0.00017 U	--	--
13 (AM-3)	GW-29 (D)	2/5/2019	0.3392	12.55	959	1.3	7.73	0.666 J	2896	0.00107 U	0.0179	1.06651	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.03453	0.00016 U	0.00554	0.00068 U	0.00017 U	0.468	0.599
13 (AM-3)	GW-29	2/5/2019	0.3321	11.797	959	1.3	7.8	0.207 J	3720	0.00107 U	0.01856	1.05644	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.03367	0.00016 U	0.00555	0.00068 U	0.00017 U	0.529	0.738
14 (AM-4)	GW-29	7/23/2019	0.3658	14.272	996	1.25	8 J	0.451	3760	0.00107 U	0.01422	1.17521	0.00022 U	0.00067 U	0.00145 U	0.00047 U	0.00052 U	0.03459	0.00016 U	0.00416	0.0034 U	0.00017 U	--	--

NOTES:

[1] Lab analyses were completed by Beta Lab and TestAmerica Laboratories, Inc., both of which are accredited/certified laboratories: Beta Lab ISO/IEC 17025 Cert No. 2489.01 (Exp. 11-30-20) and ISO/IEC 9001 Cert. No. 83761-IS7 (Exp. 01-16-21) and TestAmerica NELAP Identification Number: 68-00340, EPA Region: 3, Expiration Date: 08-31-20.

[2] Event Nos. 13 and 14 correspond to Assessment Monitoring (AM) sampling events AM-3 and AM-4, respectively.

[3] Field duplicate samples that were taken for Quality Control purposes are noted with a (D).

DATA QUALIFER DEFINITIONS:

The following definitions provide brief explanations of the validation qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the adjusted method detection limit for sample and method.
J	The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample (due either to the quality of the data generated because certain quality control criteria were not met, or the concentration of the analyte was below the reporting limit).
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
UJ	The analyte was analyzed for, but was not detected. The reported detection limit is approximate and may be inaccurate or imprecise.
R	The sample result (detected) is unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in sample
UR	The sample result (nondetected) is unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in sample.

TETRA TECH

TABLE 4-1
CCR RULE INTERWELL COMPARISON OF SAMPLING EVENT AM-1, -2, AND -3 APPENDIX IV DATA

Northern Boundary							Event 11 (AM-1) Downgradient Wells							
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-9	GW-19	GW-20	GW-23	GW-24	GW-25	GW-26[e]	
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00017	<0.00017	<0.00022	<0.00089	0.00045	<0.00025	NS	
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.00033	0.12848	0.00208	0.02904	0.02311	0.04674	NS	
Barium	mg/L	Log–Normal	Parametric	0.0934	2	2	0.05607	1.11921	0.18475	10.40809	8.53453	6.69065	NS	
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022	<0.00022	<0.00022	0.00024	NS	
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	NS	
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00045	<0.00045	0.00188	<0.0009	0.0005	0.00947	NS	
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	<0.00047	0.00217	0.00184	0.00213	NS	
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.224	1.59	***5.58***	<0.025	<0.025	<0.025	NS	
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	<0.00052	<0.00052	<0.00052	0.00599	NS	
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.01629	0.01403	0.01344	0.1054	0.03662	0.02067	NS	
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	NS	
Molybdenum	mg/L	Log–Normal	Parametric	0.006805	0.1	0.1	0.00033	<0.00028	0.09681	0.00568	0.00711	0.01146	NS	
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.0011	<0.0044	0.01997	0.00279	<0.0011	<0.0011	NS	
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	NS	
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	0.164	1.6	<1.603	86.6	49.2	24.2	NS	

Event 11 (AM-1) Upgradient Well GW-7	
<0.00017	U
<0.00075	U
0.0811	
<0.00022	UJ
<0.00017	UJ
<0.00045	U
<0.00047	UJ
7.89	J-
<0.00052	UJ
0.02062	J
<0.00004	UJ
<0.00028	U
<0.0055	UJ
<0.00017	UJ
<0.2838	U

[a]Prediction Limits calculated using 5% alpha.
[b]Upper Prediction Limit used for all parameters.
[c]Data distribution set to Unknown if all values non-detect in upgradient well.
[d]DQ is Double Quantification Rule. If Event 11 sample is detectible, will need to resample the downgradient well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 11, would use Poisson PL instead.
[e]GW-26 not sampled (NS) due to insufficient recoverable water.

#.#### = UPL > Result > MCL/RSL
(green) = SSI < GWPS
(red) = SSI > GWPS
(yellow) = DQ Parameter with Verification Sampling Needed

Northern Boundary							Event 12 (AM-2) Downgradient Wells							
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-9	GW-19	GW-20	GW-23	GW-24	GW-25	GW-26[e]	
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00017	<0.00017	<0.00024	0.00068	0.00045	0.00041	NS	
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.00068	0.08846	0.00235	0.02875	0.02401	0.04887	NS	
Barium	mg/L	Log–Normal	Parametric	0.0934	2	2	0.05274	1.08458	0.18929	10.51039	10.27638	7.03146	NS	
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022	<0.00022	<0.00022	<0.00022	NS	
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00017	<0.00017	0.00021	<0.00017	<0.00017	<0.00017	NS	
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00045	<0.00045	0.00138	<0.00045	<0.00045	0.00464	NS	
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	<0.00047	0.00211	0.00162	0.00143	NS	
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.139	1.71	***5.61***	0.062	<0.25	0.536	NS	
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	<0.00052	<0.00052	<0.00052	0.00306	NS	
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.01462	0.01314	0.01361	0.11306	0.03499	0.02258	NS	
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	NS	
Molybdenum	mg/L	Log–Normal	Parametric	0.006805	0.1	0.1	<0.00028	<0.00028	0.09825	0.00481	0.00658	0.01186	NS	
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.0011	<0.0011	0.01718	<0.0022	<0.0011	<0.0011	NS	
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	NS	
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	1.116	1.843	<1.345	85.6	38.9	28.4	NS	

Event 12 (AM-2) Upgradient Well GW-7	
<0.00017	U
<0.0006	U
0.07365	
<0.00022	U
<0.00017	U
<0.00045	U
<0.00047	U
7.61	J-
<0.00052	U
0.01916	J
<0.00004	U
<0.00028	U
<0.0044	U
<0.00017	U
<1	

[a]Prediction Limits calculated using 5% alpha.
[b]Upper Prediction Limit used for all parameters.
[c]Data distribution set to Unknown if all values non-detect in upgradient well.
[d]DQ is Double Quantification Rule. If Event 12 sample is detectible but Event 11 was ND, need to resample the well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 12, would use Poisson PL instead.
[e]GW-26 not sampled (NS) due to insufficient recoverable water.

#.#### = UPL > Result > MCL/RSL
(green) = SSI < GWPS
(red) = SSI > GWPS
(yellow) = DQ Parameter with Verification Sampling Needed

TABLE 4-1
CCR RULE INTERWELL COMPARISON OF SAMPLING EVENT AM-1, -2, AND -3 APPENDIX IV DATA

Northern Boundary							Event 13 (AM-3) Downgradient Wells								Event 13 (AM-3) Upgradient Well GW-7	
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-9	GW-19	GW-20	GW-23	GW-24	GW-25	GW-26			
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00107	<0.00107	<0.00107	<0.00426	<0.00107	<0.00426	<0.0107		<0.00107	U
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.0005	0.09721	0.00249	0.03247	0.02855	0.05652	0.03057		0.00042	
Barium	mg/L	Log−Normal	Parametric	0.0934	2	2	0.06275	1.10111	0.24056	9.76212	9.25331	7.62675	0.53473		0.07666	
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022	<0.00022	<0.00022	0.00025	0.00255		<0.00022	U
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00067	<0.00067	<0.00067	<0.0027	<0.00067	<0.0027	<0.00675		<0.00067	U
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00145	<0.00145	<0.00354	<0.0058	<0.0029	0.01045	0.0382		<0.00145	U
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	0.00058	0.00284	0.00209	0.00371	0.01594		<0.00047	U
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.203	1.63	***5.66***	0.351	0.266	<0.025	1.58		8.07	J-
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	0.00099	<0.00052	<0.00052	0.00505	0.01799		<0.00052	U
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.01743	0.01414	0.01607	0.15017	0.04512	0.03069	0.03863		0.01904	
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00016	<0.00016	<0.00016	<0.00016	<0.00016	<0.00016	<0.00163		<0.00016	U
Molybdenum	mg/L	Log−Normal	Parametric	0.006805	0.1	0.1	<0.00113	<0.00113	0.10255	0.00734	0.00853	0.01182	0.02644		<0.00113	U
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.0034	<0.0034	0.00991	<0.00068	<0.0068	<0.00068	<0.034		<0.0034	U
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	<0.00017	<0.00175		<0.00017	U
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	0.1854	2.64	0.389	83.4	46.1	30.5	1.919		0.4727	

[a]Prediction Limits calculated using 5% alpha.

[b]Upper Prediction Limit used for all parameters.

[c]Data distribution set to Unknown if all values non-detect in upgradient well.

[d]DQ is Double Quantification Rule. If Event 13 sample is detectible but Event 12 was ND, need to resample the well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 13, would use Poisson PL instead.

#.#### = UPL > Result > MCL/RSL

(green) = SSI < GWPS

(red) = SSI > GWPS

(yellow) = DQ Parameter with Verification Sampling Needed

TETRA TECH

TABLE 4-2
CCR RULE INTERWELL COMPARISON OF SAMPLING EVENT AM-1, -2, AND -3 APPENDIX IV DATA

Western Boundary							Event 11 (AM-1) Downgradient Wells							
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-27	GW-28	GW-29					
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00017	<0.00017	<0.00017					
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.00036	0.00494	0.01792					
Barium	mg/L	Log–Normal	Parametric	0.0934	2	2	0.81784	0.23483	1.01725					
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022					
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00017	<0.00017	<0.00017					
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00045	<0.00045	<0.00045					
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	<0.00047					
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.2705	1.91	1.1					
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	<0.00052					
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.013105	0.01558	0.03304					
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00004	<0.00004	<0.00004					
Molybdenum	mg/L	Log–Normal	Parametric	0.006805	0.1	0.1	0.004645	0.03037	0.00421					
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.0011	<0.0011	<0.0011					
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017					
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	1.398	1.304	0.806					

Event 11 (AM-1) Upgradient Well GW-7	
<0.00017	U
<0.00075	U
0.0811	
<0.00022	UJ
<0.00017	UJ
<0.00045	U
<0.00047	UJ
7.89	J-
<0.00052	UJ
0.02062	J
<0.00004	UJ
<0.00028	U
<0.0055	UJ
<0.00017	UJ
<0.2838	U

[a]Prediction Limits calculated using 5% alpha.
[b]Upper Prediction Limit used for all parameters.
[c]Data distribution set to Unknown if all values non-detect in upgradient well.
[d]DQ is Double Quantification Rule. If Event 11 sample is detectible, will need to resample the downgradient well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 11, would use Poisson PL instead.

#.#### = UPL > Result > MCL/RSL
(green) = SSI < GWPS
(red) = SSI > GWPS
(yellow) = DQ Parameter with Verification Sampling Needed

Western Boundary							Event 12 (AM-2) Downgradient Wells							
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-27	GW-28	GW-29					
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00017	<0.00017	<0.00017					
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.00047	0.00512	0.01337					
Barium	mg/L	Log–Normal	Parametric	0.0934	2	2	0.850025	0.2713	0.94805					
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022					
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00017	<0.00017	<0.00017					
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00045	<0.00045	<0.00045					
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	<0.00047					
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.2735	2.06	1.23					
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	<0.00052					
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.01269	0.01811	0.03224					
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00004	<0.00004	<0.00004					
Molybdenum	mg/L	Log–Normal	Parametric	0.006805	0.1	0.1	0.00461	0.03482	0.0039					
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.0011	<0.0011	<0.0011					
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017					
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	<2	<1.0411	<1.393					

Event 12 (AM-2) Upgradient Well GW-7	
<0.00017	U
<0.0006	U
0.07365	
<0.00022	U
<0.00017	U
<0.00045	U
<0.00047	U
7.61	J-
<0.00052	U
0.01916	J
<0.00004	U
<0.00028	U
<0.0044	U
<0.00017	U
<1	

[a]Prediction Limits calculated using 5% alpha.
[b]Upper Prediction Limit used for all parameters.
[c]Data distribution set to Unknown if all values non-detect in upgradient well.
[d]DQ is Double Quantification Rule. If Event 12 sample is detectible but Event 11 was ND, need to resample the well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 12, would use Poisson PL instead.

#.#### = UPL > Result > MCL/RSL
(green) = SSI < GWPS
(red) = SSI > GWPS
(yellow) = DQ Parameter with Verification Sampling Needed

TETRA TECH

TABLE 4-2
CCR RULE INTERWELL COMPARISON OF SAMPLING EVENT AM-1, -2, AND -3 APPENDIX IV DATA

Western Boundary							Event 13 (AM-3) Downgradient Wells							
Parameter	Units	Data Distribution for Upgradient Well GW-7	UPL Type	UPL Value[a,b]	Federal MCLs/RSLs	GWPS	GW-27	GW-28	GW-29					
Antimony	mg/L	Unknown	Poisson	0.00133	0.006	0.006	<0.00017	<0.00017	<0.00017					
Arsenic	mg/L	Unknown	Poisson	0.00682	0.01	0.01	0.00035	0.00554	0.01823					
Barium	mg/L	Log−Normal	Parametric	0.0934	2	2	0.91402	0.24927	1.061475					
Beryllium	mg/L	Unknown[c]	DQ[d]	NA	0.004	0.004	<0.00022	<0.00022	<0.00022					
Cadmium	mg/L	Unknown[c]	DQ[d]	NA	0.005	0.005	<0.00067	<0.00067	<0.00067					
T. Chromium	mg/L	Unknown[c]	DQ[d]	NA	0.1	0.1	<0.00145	<0.00145	<0.00145					
Cobalt	mg/L	Unknown[c]	DQ[d]	NA	0.006	0.006	<0.00047	<0.00047	<0.00047					
Fluoride	mg/L	Normal	Parametric	9.291	4	9.291	0.305	2.02	1.3					
Lead	mg/L	Unknown[c]	DQ[d]	NA	0.015	0.015	<0.00052	<0.00052	<0.00052					
Lithium	mg/L	Normal	Parametric	0.023374	0.04	0.04	0.01319	0.01657	0.0341					
Mercury	mg/L	Unknown	Poisson	0.00031	0.002	0.002	<0.00016	<0.00016	<0.00016					
Molybdenum	mg/L	Log−Normal	Parametric	0.006805	0.1	0.1	0.00346	0.0341	0.005545					
Selenium	mg/L	Unknown[c]	DQ[d]	NA	0.5	0.5	<0.00068	<0.0034	<0.00068					
Thallium	mg/L	Unknown[c]	DQ[d]	NA	0.002	0.002	<0.00017	<0.00017	<0.00017					
Sum Ra226+Ra228	pCi/L	Unknown	Poisson	0.58	5	5	1.396	0.366	1.167					

Event 13 (AM-3) Upgradient Well GW-7	
<0.00107	U
0.00042	
0.07666	
<0.00022	U
<0.00067	U
<0.00145	U
<0.00047	U
8.07	J-
<0.00052	U
0.01904	
<0.00016	U
<0.00113	U
<0.0034	U
<0.00017	U
0.4727	

[a]Prediction Limits calculated using 5% alpha.

[b]Upper Prediction Limit used for all parameters.

[c]Data distribution set to Unknown if all values non-detect in upgradient well.

[d]DQ is Double Quantification Rule. If Event 13 sample is detectible but Event 12 was ND, need to resample the well to see if two successive, independent detected values occur. If so, that would be an SSI. If value was detected in upgradient well in Event 13, would use Poisson PL instead.

#.#### = UPL > Result > MCL/RSL

(green) = SSI < GWPS

(red) = SSI > GWPS

(yellow) = DQ Parameter with Verification Sampling Needed

TABLE 4-3

CCR RULE NATURE AND EXTENT OF RELEASE CHARACTERIZATION SAMPLING ANALYTICAL RESULTS SUMMARY

McELROY'S RUN CCB DISPOSAL FACILITY - 2019 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

			APPENDIX III (all Chemical Constituents reported as TOTAL RECOVERABLE)[1]							APPENDIX IV (all Chemical Constituents reported as TOTAL RECOVERABLE)[1]														
SAMPLING EVENT NO.[2]	WELL ID	SAMPLE DATE	BORON METALS MG/L	CALCIUM METALS MG/L	CHLORIDE MISC MG/L	FLUORIDE MISC MG/L	PH MISC S.U.	SULFATE MISC MG/L	TDS MISC MG/L	ANTIMONY METALS MG/L	ARSENIC METALS MG/L	BARIUM METALS MG/L	BERYLLIUM METALS MG/L	CADMIUM METALS MG/L	CHROMIUM METALS MG/L	COBALT METALS MG/L	LEAD METALS MG/L	LITHIUM METALS MG/L	MERCURY METALS MG/L	MOLYBDENUM METALS MG/L	SELENIUM METALS MG/L	THALLIUM METALS MG/L	RADIUM-226 RADIOCHEM PCI/L	RADIUM-228 RADIOCHEM PCI/L
N&E-1	GW-12	7/25/2019	0.075 U	28.381	1.66	0.025 U	6.47 J	39.3	172	--	0.00041	0.06043	--	--	--	--	--	0.0005 U	--	--	--	--	--	--
N&E-1	GW-17	7/25/2019	1.6 J+	208	79.8	0.15	7.29 J	460	1025	--	0.00035 U	0.10882	--	--	--	--	--	0.01946	--	--	--	--	--	--

NOTES:

[1] Lab analyses were completed by Beta Lab and TestAmerica Laboratories, Inc., both of which are accredited/certified laboratories: Beta Lab ISO/IEC 17025 Cert No. 2489.01 (Exp. 11-30-20) and ISO/IEC 9001 Cert. No. 83761-IS7 (Exp. 01-16-21) and TestAmerica NELAP Identification Number: 68-00340, EPA Region: 3, Expiration Date: 08-31-20.

[2] Event No. N&E-1 was dedicated solely to Nature and Extent of Release Characterization purposes using two WVDEP monitoring program wells and analyzing for Appendix III parameters and for Appendix IV parameters exhibiting SSLs in the CCR monitoring program wells.

DATA QUALIFER DEFINITIONS:

The following definitions provide brief explanations of the validation qualifiers assigned to results in the data review process.

- U — The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the adjusted method detection limit for sample and method.
- J — The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample (due either to the quality of the data generated because certain quality control criteria were not met, or the concentration of the analyte was below the reporting limit).
- J+ — The result is an estimated quantity, but the result may be biased high.
- J- — The result is an estimated quantity, but the result may be biased low.
- UJ — The analyte was analyzed for, but was not detected. The reported detection limit is approximate and may be inaccurate or imprecise.
- R — The sample result (detected) is unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in sample
- UR — The sample result (nondetected) is unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in sample.

FIGURES

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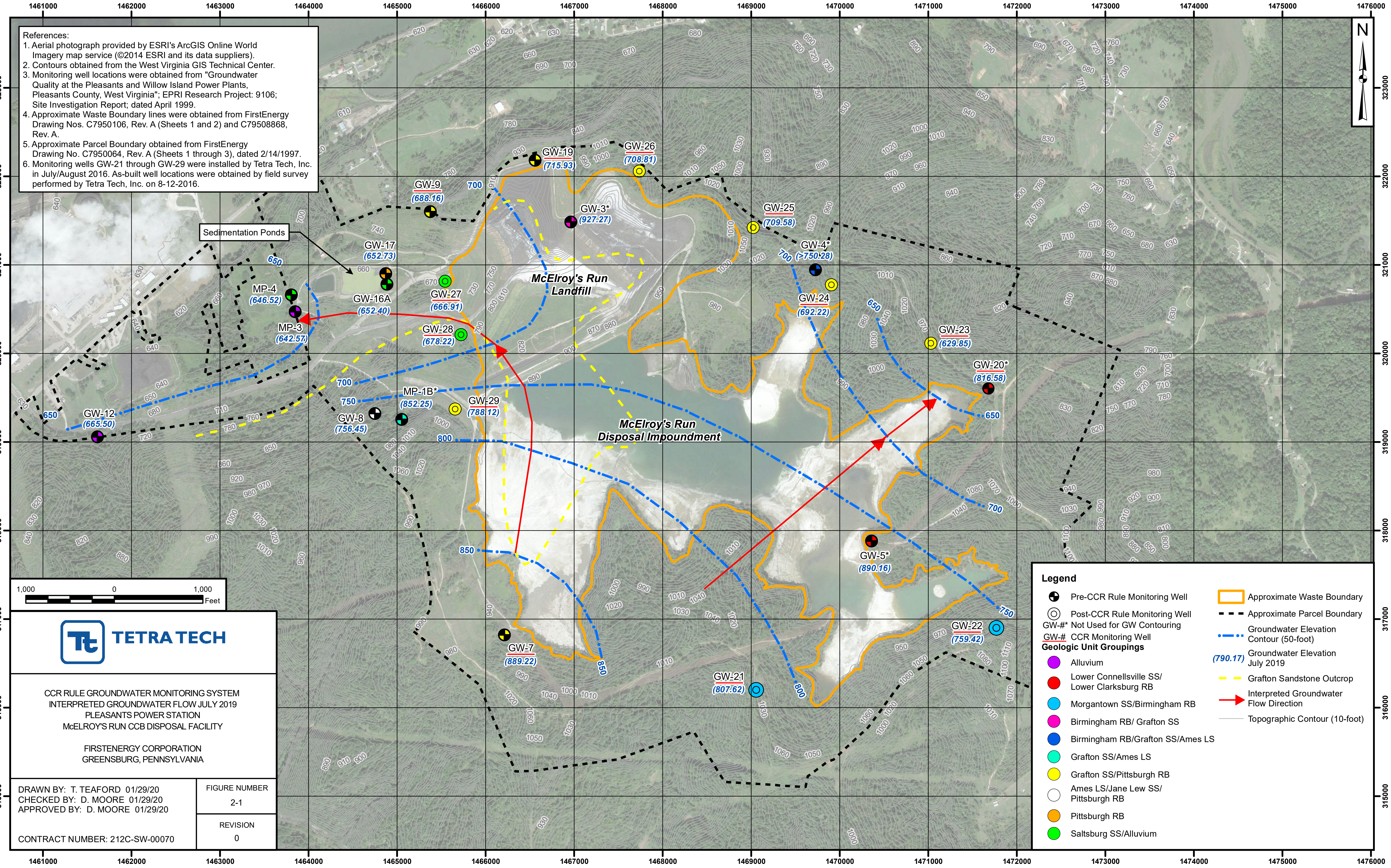

ATTACHMENT A

CCR Rule Appendix IV Alternative Source Demonstration Report – 2018/2019 Assessment Monitoring

McElroy's Run Coal Combustion Byproduct Disposal Facility

Pleasants Power Station
Pleasants County, West Virginia

Prepared for:

FirstEnergy

800 Cabin Hill Drive
Greensburg, PA 15601

Prepared by:

Tetra Tech, Inc.

400 Penn Center Boulevard, Suite 200
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Tetra Tech Project No. 212C-SW-00070

October 2019

CCR RULE APPENDIX IV ALTERNATIVE SOURCE DEMONSTRATION REPORT
2018/2019 ASSESSMENT MONITORING

McELROY'S RUN COAL COMBUSTION BYPRODUCT DISPOSAL FACILITY

PLEASANTS POWER STATION
PLEASANTS COUNTY, WEST VIRGINIA

Prepared for:

FirstEnergy

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Tetra Tech Project No. 212C-SW-00070

October 2019

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1.0 INTRODUCTION/BACKGROUND

FirstEnergy (FE) owns and operates the coal-fired Pleasants Power Station (hereinafter referred to as the “Station”) located in Pleasants County, West Virginia. Coal Combustion Residuals (CCRs) produced at the Station are placed in the facility’s Coal Combustion Byproduct Disposal Facility (CCBDF or “CCR unit”), which is located approximately one mile east-southeast of the Station (see Figure 1). The facility consists of both a wet disposal area (impoundment) and dry disposal area (landfill) developed in the McElroy’s Run watershed. Taken together, the landfill and impoundment are regulated under West Virginia Department of Environmental Protection (WVDEP) Solid Waste/National Pollutant Discharge Elimination System (NPDES) Water Pollution Control Permit No. WV0079171, and the United States Environmental Protection Agency (USEPA) Disposal of Coal Combustion Residuals from Electric Utilities rule (40 CFR Part 257, hereinafter referred to as the “CCR Rule” or “Rule”). As per the CCR Rule, the landfill and impoundment are considered two separate, existing CCR units that share a common boundary (the impoundment dam). As provided by the CCR Rule, a multiunit groundwater monitoring system has been established for the CCBDF.

In accordance with § 257.94 of the Rule, the initial Detection Monitoring (DM) sampling and analysis event for the CCR unit was completed in October 2017, and the statistical evaluation of the resulting data was completed in January 2018. As required by § 257.90(e), the results and findings from the 2017 groundwater monitoring program were documented in the 2017 Annual Groundwater Monitoring and Corrective Action Report (AGWMCA Report) that was posted in both the CCR unit’s operating record and on its publicly accessible website in January 2018 (Tetra Tech, 2018). In that report, Statistically Significant Increases (SSIs) for boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids (TDS) were determined in several downgradient monitoring wells. Based on the various parameters for which SSIs were identified, an Appendix III Alternative Source Demonstration (ASD) was undertaken as discussed in the 2018 AGWMCA Report (Tetra Tech, 2019). However, all of the Appendix III SSIs that were identified for DM-1 could not be attributed to alternative sources.

During the transition period between completing the statistical evaluation of the DM-1 data and performing the Appendix III ASD, FE performed another round of DM sampling (event DM-2) in order to have data available should the ASD prove to be successful and the facility remained in the DM program. DM-2 sampling occurred in February 2018, with laboratory analysis and data validation completed by April 2018. However, before statistical evaluation of the DM-2 data commenced, it was determined that a transition to Assessment Monitoring (AM) was required which precluded the need to statistically evaluate the DM-2 data. As such, a transition to the applicable requirements of AM per § 257.95 of the CCR Rule commenced.

In accordance with 40 CFR § 257.95(b) and (d)(1), two AM sampling events (AM-1 and AM-2) were performed in May and August 2018. Pursuant to §§ 257.94(e)(3), 257.105(h)(5), and 257.106(h)(4), a notice was posted to the facility's Operating Record and issued to the WVDEP in August 2018, to provide notification that a groundwater Assessment Monitoring program for the CCR unit had been established. Pursuant to § 257.107(h)(4), the subject notice was posted to the facility's publicly accessible website in September 2018. Analytical data summary tables and a description of the 2018 AM program results can be found in the 2018 AGWMCA Report (Tetra Tech, 2019). Once initiated, the AM program continued in 2019 with two additional sampling events performed in February (AM-3) and July (AM-4).

Statistical evaluation of the AM sampling events was completed in January 2019 for AM-1 and -2 and in August 2019 for AM-3 (validated AM-4 results were not available in time to be included in this report). The statistical evaluations indicated Appendix IV constituent concentrations in downgradient wells at Statistically Significant Levels (SSLs) above applicable Groundwater Protection Standards (GWPS). In accordance with 40 CFR § 257.106(h)(6), a notice was prepared and posted to the facility's Operating Record, issued to the WVDEP, and then posted on the facility's publicly accessible website in April 2019, to provide notification of the SSLs for arsenic, barium, fluoride, lithium, and radium at the CCR unit.

During this same notification period and in accordance with 40 CFR § 257.95(g)(3)(ii), an Appendix IV ASD was initiated to assess if the SSLs determined for the AM-1, AM-2, and AM-3 events were attributable to a release from the CCR unit, from a demonstrable alternative source(s), or if they resulted from errors in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Pursuant to § 257.95(g)(4), if a successful ASD has not been completed within 90 days from the date of determining that an SSL has occurred, the CCR unit owner or operator must initiate an Assessment of Corrective Measures (ACM) in accordance with 40 CFR § 257.96. Due to the additional monitoring points, sampling events, laboratory analyses, and evaluations needed to complete a successful ASD, the work to complete the ASD had to be extended. Therefore, and in accordance with 40 CFR § 257.106(h)(7), a separate notice was prepared and posted to the facility's Operating Record, issued to the WVDEP, and then posted on the facility's publicly accessible website in April 2019, to provide notification of the initiation of the assessment of corrective measures for arsenic, barium, fluoride, lithium, and radium at the Site.

Subsequent to the above-referenced AM notifications, additional rounds of groundwater level data were collected and evaluated which resulted in a modified interpretation of current groundwater flow patterns along the northern boundary of the Site than were described in the *CCR Rule Groundwater Monitoring System Evaluation Report for the Pleasants Power Station* (Tetra Tech, 2017). In the subject report there were two, separate upgradient/background wells identified for the western and northern boundaries of the CCR unit. The current understanding of groundwater flow based on the additional rounds of groundwater level measurements is such that one upgradient well, GW-7, is now considered the upgradient/background well for both the western and northern boundaries of the CCR unit (Figure 2). This change in groundwater flow pattern is likely attributable to the low permeability of the formation and long stabilization period required for the wells installed along the northern boundary. As such, the AM statistical evaluations that have recently been conducted have incorporated upper prediction limits (UPLs) associated with GW-7 for both boundaries.

The table shown on the following page summarizes the results of the statistical evaluation of the CCR Rule Appendix IV parameters based upon utilizing the updated groundwater flow interpretation (i.e., utilizing the GW-7 UPL for comparison with downgradient constituent concentrations) and lists which wells (labeled "GW-#") have parameters that were determined to be above their GWPS. The revised statistical evaluation based on the updated understanding of groundwater flow patterns determined that arsenic SSLs occurred in more wells than previously indicated (due to the lower arsenic GWPS for MW-7), but that fluoride was no longer an SSL in the single well it was previously found in (GW-20) due to the higher fluoride GWPS for MW-7. As such, fluoride is no longer considered an SSL and was not evaluated in this ASD. A detailed discussion of the revised interpretation of groundwater flow patterns at the site and the associated impacts on statistical evaluations of AM data will be provided in the forthcoming 2019 AGMCA Report that will be issued in January 2020.

After initiating the ACM in April 2019, the ongoing ASD activities were continued as they indicated a strong possibility that the barium, lithium, and radium SSLs were attributable to demonstrable alternative source(s). As such, this ASD report has been prepared to document the evaluation of the AM-1, -2, and -3 Appendix IV SSLs and to incorporate the findings into the CCR unit's ACM.

Appendix IV Parameters [GWPS]	Northern Boundary (Upgradient Well GW-7)					Western Boundary (Upgradient Well GW-7)
	GW-19	**GW-23**	**GW-24**	**GW-25**	**GW-26**	**GW-29**
Arsenic (As) [0.01 mg/L]	**SSL**	**SSL**	**SSL**	**SSL**	**SSL**	**SSL**
AM-1	0.1285	0.0290	0.0231	0.0467	n/s	0.0179
AM-2	0.0885	0.0288	0.0240	0.0489	n/s	0.0134
AM-3	0.0972	0.0325	0.0286	0.0565	0.0306	0.0186
Barium (Ba) [2 mg/L]		**SSL**	**SSL**	**SSL**	**SSL**	
AM-1	<GWPS	10.41	8.53	6.69	n/s	<GWPS
AM-2	<GWPS	10.51	10.28	7.03	n/s	<GWPS
AM-3	<GWPS	9.76	9.25	7.63	0.53473	<GWPS
Lithium (Li) [0.04 mg/L]		**SSL**	**SSL**			
AM-1	<GWPS	0.1054	<GWPS	<GWPS	n/s	<GWPS
AM-2	<GWPS	0.1131	<GWPS	<GWPS	n/s	<GWPS
AM-3	<GWPS	0.1502	0.0451	<GWPS	<GWPS	<GWPS
Radium (Ra 226 + 228) [5 pCi/L]		**SSL**	**SSL**	**SSL**		
AM-1	<GWPS	86.5	49.3	24.2	n/s	<GWPS
AM-2	<GWPS	85.6	38.8	28.4	n/s	<GWPS
AM-3	<GWPS	83.4	46.1	30.5	<GWPS	<GWPS

Note: Downgradient well GW-26 was not sampled (n/s) during the AM-1 and AM-2 events due to insufficient available water.

2.0 APPROACH

For this ASD, a multiple Line of Evidence (LOE) approach as presented in *Guidance for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites* (EPRI, 2017) was followed. This approach divides LOEs into five separate ASD categories (types):

- Sampling causes (ASD Type I);
- Laboratory causes (ASD Type II);
- Statistical evaluation causes (ASD Type III);
- Natural variation not accounted for in the basic DM statistics (ASD Type IV); and
- Potential natural or anthropogenic sources (ASD Type V).

EPRI (2017) includes detailed checklists that provide a standardized, incremental approach that is followed to determine whether additional LOE evaluations are warranted or not. These checklists include:

- Checklist 1: Sampling, Laboratory, or Statistical Causes (ASD Types I, II, and III);
- Checklist 2: LOEs Associated with the CCR Unit (ASD Type IV); and
- Checklist 3: LOEs Associated with Alternative Natural or Anthropogenic Sources (ASD Type V).

For this ASD all three Checklists were completed and are attached as Tables 1, 2, and 3. Based on indications from these checklists as well as the CCR unit's topographic and geologic setting, development and operational history, and currently available information and data, it was determined that additional evaluations of the following site-specific LOEs were warranted:

- Regional groundwater chemistry studies/reports; and
- Potential existing and historic oil and/or gas production well effects.

The findings from the checklist completion activities and site-specific LOE evaluations are summarized in Section 3.0.

3.0 SUMMARY OF FINDINGS

3.1 ASD CHECKLIST 1

ASD Checklist 1 is attached as Table 1 of this report. The checklist evaluations were performed by re-reviewing the CCR groundwater monitoring program's field sampling notes and chain-of-custody forms, laboratory data validation (Level 2) reports, statistical evaluation spreadsheets, and results from field-filtered duplicate samples that were obtained during events where turbid unfiltered samples had been obtained. As indicated in Table 1, for many potential sampling, laboratory, or statistical evaluation causes, no instances/issues/indications were identified. Sample contamination with petroleum and/or brine from on-site oil and gas exploration and production activities could be a contributing factor for the SSIs and SSLs for barium, lithium, and radium in GW-23, -24, and -25 (as discussed in Section 3.5 of this report, barium, lithium, and radium have been documented as being associated with oil and gas well brines). For other potential causes where some issues were identified, it was determined that they most likely did not contribute to the Appendix IV SSLs.

Based on these LOE findings, laboratory analysis and statistical evaluations are not demonstrable alternative sources of all the Appendix IV SSLs determined for the AM-1, -2, and -3 events, while sample turbidity and contamination are potential sources of the SSIs and SSLs determined for barium, lithium, and radium in some of the downgradient monitoring wells.

3.2 ASD CHECKLIST 2

ASD Checklist 2 is attached as Table 2 of this report. The checklist evaluations were performed by re-reviewing the groundwater analytical results (background, DM, and AM) for both Appendix III and IV parameters, leachate data for the CCR unit (specifically for arsenic, barium, lithium, and radium) provided by FE, and hydrogeologic and design information and data included in *CCR Rule Groundwater Monitoring System Evaluation Report for the Pleasants Power Station* (Tetra Tech, 2017). For the LOEs in Checklist 2, the following evaluation criteria were used:

- Primary Indicators – As per Table A-1 in EPRI (2017), primary indicator constituents for CCRs include the CCR Rule parameters Boron (Appendix III), Calcium (Appendix III), Chloride (Appendix III), Fluoride (Appendix III and IV), Lithium (Appendix IV), Molybdenum (Appendix IV), and Sulfate (Appendix III), as well as Bromide, Potassium, and Sodium, which are parameters that are not listed in the CCR Rule.

- Secondary Indicators – For this ASD, secondary indicator constituents for CCRs include those Appendix III and IV constituents that are not considered primary indicators.
- Leachate Data – Analytical results from five leachate sampling events performed at the CCR unit between October 2017 and July 2019 at three locations (LM1, LM5, and LM7) were used for comparison to the February 2019 AM-3 groundwater results, as shown in Table 4. The comparison of data for barium and radium indicates that barium is found at higher concentrations in groundwater in both the upgradient well and in all the downgradient wells than in leachate, whereas radium is found at higher concentrations in only the downgradient wells than in leachate, indicating a localized, non-CCR source exists along the northern boundary of the CCR unit. Alternatively, concentrations of arsenic and lithium in the leachate samples are several times higher than those of the upgradient well and the downgradient wells, indicating that the arsenic and lithium SSLs in groundwater are likely attributable to a release from the CCR unit.
- Site Hydrogeology - As discussed in the *CCR Rule Groundwater Monitoring System Evaluation Report* (Tetra Tech, 2017), groundwater in the CCBDF area occurs primarily within the fractured bedrock of multiple Conemaugh Group sandstone units including the Morgantown, Grafton, Jane Lew, and Saltsburg, which have been collectively identified as the uppermost aquifer for CCR Rule groundwater monitoring for the combined landfill and impoundment units. The CCR groundwater monitoring well network at the site is shown on Figure 1 and consists of three upgradient (background) wells (GW-7, -21, and -22), six downgradient wells to monitor the northern side of the combined CCR units (GW-19, -20, -23, -24, -25, and -26), and four downgradient wells to monitor the western side of the combined CCR units (GW-9, -27, -28, and -29). Historic and recent groundwater level data indicate groundwater flow at the site as flowing north from the topographically higher areas located to the south and southeast of the impoundment. Groundwater flow northwest of the dam and under the landfill is in the downstream direction of McElroy's Run toward the west. Flow in all of the rock units exhibit little seasonal and temporal fluctuations.

  Having sufficient recoverable volumes of groundwater from one of the upgradient (GW-21) and three of the downgradient wells (GW-23, -24, and -25) was found to be problematic during both the background and initial DM sampling events. These four wells were noted to have low to very low yields during their installation and development which was anticipated given that historical well borings drilled at the site under the WVDEP groundwater monitoring program were abandoned over time due to a lack of water in the same rock units. During the initial DM sampling event, sufficient recoverable groundwater volumes were found to be available in GW-23 and -24 but not in GW-21, -25, or in an additional downgradient well, GW-26. Geologic and hydrogeologic characteristics of the site, the monitoring well network, and the initial DM results are discussed in greater detail in both Tetra Tech 2017 and 2018.

It was originally intended that upgradient wells GW-21 and GW-22, which are both screened in the Morgantown sandstone, would be grouped for statistical evaluation purposes. However, after both the background and the initial DM sampling events were completed, it was determined that the two wells did not have the level of statistical similarity needed for grouping and that the availability of sufficient volumes of recoverable water was a recurring problem for GW-21. As such, it was decided that only GW-22 would be used to establish background chemistry for the northern side of the CCR units since it exhibited lower concentrations of all the Appendix III parameters than those measured in GW-21 and it also provided a reliable water yield while GW-21 did not. GW-21 was left in place (i.e., it was not abandoned) and it has been sampled when sufficient volumes of recoverable water were available. GW-21's water levels have also continued to be used to verify groundwater flow patterns at the site. FE intends is to keep GW-21 as a part of the CCR monitoring network until a sufficiently-sized data set can be compiled and used to determine whether or not it's statistically appropriate to group its results with the data set for GW-22. As discussed in Section 1.0, recent groundwater elevation measurements and mapping of the potentiometric surface indicate that GW-7, instead of a combination of GW-7 and GW-22 for the western and northern boundaries, respectively, acts as the upgradient well for the CCR network for both the western and northern boundary CCR wells as shown on Figure 2.

- CCR Unit Design - As shown on Figure 1, the CCR unit consists of two conterminous disposal areas, an impoundment and a landfill, that share a common boundary (the impoundment dam). The majority of the CCR material that has been disposed of at the site is managed in an unlined impoundment formed by a dam constructed across McElroy's Run. The dam was constructed with a clay-filled cutoff trench at the upstream toe and a clay blanket on the upstream face to function as a low permeability barrier. The downstream portion of the dam was constructed using compacted fly ash and periodic layers of bottom ash for blanket drains connected to sloping chimney drains that collect seepage to discharge pipes for monitoring. The downstream face of the dam is covered by the landfill facility which WVDEP considers to be a buttress to the dam.

The landfill consists of three primary development stages which are further subdivided into construction subareas. At this time, development and disposal operations have only been performed in Stages 1 and 2 and the Stage 3 area remains undeveloped. Up until 2009 all of the landfill subareas were constructed with a compacted clay liner system that included an underlying combined groundwater underdrain/leak detection system and an overlying leachate collection system. Since 2009 a composite geosynthetic liner system (geosynthetic clay liner and geomembrane) has been utilized which also includes an underlying combined groundwater underdrain/leak detection system and an overlying leachate collection system. For all portions of the landfill that overlie the downstream face of the impoundment dam, a bottom ash blanket drain layer has also been utilized. Leachate and contact stormwater runoff from the landfill disposal areas are managed in Sedimentation Pond Nos. 1 and 2, which are lined impoundments located immediately down-valley of the future Stage 3 landfill development area. These impoundments also accept flows from the groundwater underdrain/leak detection zones and stormwater runoff from portions of the landfill's South Haul Road. Discharges from Sedimentation Pond Nos. 1 and 2 are pumped up to the CCR disposal impoundment and, ultimately, routed through the impoundment's dewatering system.

Based on the various LOE findings presented in Table 2, arsenic and possibly lithium SSLs determined for the AM-1, -2, and -3 events can most likely be attributed to a release from the CCR unit. However, the comparison of leachate data to upgradient and downgradient wells indicates that a source other than the CCR unit may be contributing to the occurrence of barium and radium in groundwater.

3.3 ASD CHECKLIST 3

ASD Checklist 3 is attached as Table 3 of this report. The checklist evaluations were performed similar to those of ASD Checklist 2 by re-reviewing the groundwater analytical results (background, DM, and AM) for both Appendix III and IV parameters, leachate data for the CCR unit (specifically for barium, lithium, and radium) provided by FE, and hydrogeologic and design information and data included in *CCR Rule Groundwater Monitoring System Evaluation Report for The Pleasants Power Station* (Tetra Tech, 2017). For the LOEs in Checklist 3, the following evaluation criteria were used in addition to those used for ASD Checklist 2:

- Results of AM/Nature and Extent of Release (N&E) groundwater sampling conducted in February and July 2019 indicate that an alternate source of barium, lithium, and radium appears to exist along the northern boundary as shown on Figures 3, 4, and 5, respectively. Isoconcentration contour lines located around these northern boundary wells indicate a localized source of all three parameters in this area. Historical and current oil and gas exploration and production activities have occurred in this area and are documented sources of barium, radium, and lithium that could be the source of the SSLs in the northern boundary wells. These results and associated comparisons are discussed in greater detail in Section 3.5 of this report.
- Review of site-wide boring logs for observations of potential oil and gas well impacts to groundwater during previous investigations identified several wells in which oil and gas impacts were noted. Observations of petroleum/hydrocarbon odor, sheen, and/or crude oil product were noted for the following wells at the time of their installation (copies of the relevant pages from each log are included as Attachment A of this report):
    - GW-3 – light hydrocarbon odor
    - GW-4 – oil odor
    - GW-5 – oil odor and sheen
    - GW-6 – black crude in rock cuttings
    - GW-7 – hydrocarbon odor, black crude in rock cuttings
    - P-96-4 – oil odor
    - P-96-5 – crude oil odor
    - N-3 – oil odor
    - GW-13 – crude oil in sandstone, visual staining
    - GW-15 – 0.32 feet of crude oil-fingerprinted product
    - GW-19 – crude oil odor
    - GW-24 – petroleum hydrocarbon odor
    - GW-25 – petroleum hydrocarbon odor

Based on the LOE findings presented in Table 3 and the discussion above, the barium, radium, and lithium SSLs determined for the AM-1, -2, and -3 events can most likely be attributed to historical and current oil and gas exploration and production activities. While lithium has also been shown to be a component of oil and gas well brine, the relatively high concentrations of lithium in the leachate is an indication that the CCR unit may be the source of the lithium SSLs.

3.4 REGIONAL GROUNDWATER STUDY

In an effort to evaluate the natural variation in groundwater quality in the various water producing units of the Conemaugh Group (e.g., Morgantown, Grafton, Jane Lew, and Saltsburg sandstones) which comprise the CCR Rule uppermost aquifer, *Ground-Water Hydrology of the Minor Tributary Basins of the Ohio River, West Virginia* (USGS, 1984) was reviewed. The report review did not yield any specific information regarding natural variation of arsenic, barium, lithium, or radium in regional groundwater. However, the following table presents the range and mean concentrations reported for Appendix III constituents with SSIs in the Conemaugh Group wells which can be compared with CCR unit well data that point to oil and gas exploration activities as an alternative source:

	Dissolved Chloride (mg/L)	Dissolved Sulfate (mg/L)	TDS (mg/L)
No. of Wells	6	6	6
Range	2.6 - 130	10 - 88	241 - 589
Mean	31	37	371

Based on these reported values, the following observations were made:

- **Chloride -** The reported mean concentration of 31 mg/L is below the UPL for upgradient well GW-7 (104 mg/L), and the reported maximum concentration of 130 mg/L is slightly higher than the GW-7 UPL. With respect to downgradient wells along the northern boundary with Appendix IV SSLs, the reported maximum chloride concentration of 130 mg/L is well below the concentrations of chloride in GW-23 (12,900 mg/L), GW-24 (8,520 mg/L), and GW-25 (7,110 mg/L).
- **Sulfate** – Sulfate concentrations tend to have an inverse relationship with other parameters typically present in groundwater impacted by oil and gas activities. Accordingly, the reported minimum concentration of 10 mg/L is significantly higher than both the GW-7 UPL of 0.5 mg/L and the sulfate concentrations in downgradient wellsGW-23 (0.2664 mg/L), GW-24 (<0.0386 mg/L), and GW-25 (0.618 mg/L).
- **TDS** – The reported mean concentration of 371 mg/L is well below the UPL for GW-7 (1,260 mg/L). The reported maximum TDS concentration of 589 mg/L is also well below

the GW-7 UPL. With respect to downgradient wells with Appendix IV SSLs, the reported maximum TDS concentration of 589 mg/L is well below the concentrations of TDS for GW-23 (68,500 mg/L), GW-24 (42,400 mg/L), and GW-25 (35,900).

The comparisons noted above indicate that upgradient chloride and TDS concentrations (all indicators of oil and gas brine) at the site appear to be higher than the concentrations measured in regional Conemaugh Group groundwater during the USGS study period, while upgradient sulfate concentrations appear to be within the range of or below the concentrations measured in the study. However, comparing the maximum reported study results to the results for the corresponding downgradient wells with Appendix IV SSL concentrations indicates that all of the wells exhibit chloride and TDS concentrations that are higher to much higher than those for regional groundwater. Reduced sulfate, elevated chloride and, to a lesser extent, elevated TDS concentrations are typically observed with oil and gas exploration and production activities as discussed in the following section.

3.5 POTENTIAL FOR OIL AND GAS WELL IMPACTS

In an effort to evaluate the potential for oil and gas well development on and near the site to have impacted groundwater for the SSL constituents, particularly barium, lithium, and radium, and to substantiate the results of Checklist 3, several lines of evidence related to oil and gas impacts were evaluated including a review of nearby oil and gas wells and their completion records, historical research related to oil and gas exploration activities near the site, research related to the occurrence of the site's SSL constituents in oil and gas activities, and historical investigations and studies performed at the site regarding oil and gas impacts.

3.5.1 Nearby Oil and Gas Well Locations and Completion Information

The locations of oil and gas wells and basic information on the wells (e.g., total depth, date drilled, status, etc.) were obtained from the West Virginia Geologic and Economic Survey (WVGES) online oil and gas well database (http://ims.wvgs.wvnet.edu/WVOG/viewer.htm). Figure 6 presents the locations of these wells relative to the CCR monitoring well network and includes field observations of existing on-site oil and gas wells and associated infrastructure as well as groundwater sampling field notes that indicate oil and gas well-related impacts (e.g., sheen, odor, free product). A total of more than 100 existing or plugged/abandoned oil and gas wells were identified as shown on Figure 6. The table below summarizes key information for these wells obtained from the online database records:

API #	Completion Year	Well Type	Operator	Total Depth (ft)	Deepest Formation
4707300005		Oil	Oper in Min.owner fld,no code assgn(Orphan well proj)	1052	Undiff Price below Big Injun
4707300008		Oil	Oper in Min.owner fld,no code assgn(Orphan well proj)	512	Undetermined unit
4707300043	1935	Dry w/ Oil Show	All In One Producing & Refining Co., The	71	Big Injun (Price & equivs)
4707300069	1936	Oil w/ Gas Show	Feeney Oil & Gas	1600	Squaw
4707300069	1941	Dry w/ O&G Show	Feeney Oil & Gas	3379	Berea Sandstone
4707300073		Dry	Love, C. E.	1903	
4707300124	1939	Oil w/ Gas Show	Columbian Carbon Co.	5311	Oriskany Sandstone
4707300170	1940	Oil w/ Gas Show	Columbian Carbon Co.	2280	Up Devonian undiff:Berea to Lo Huron
4707300179	1940	Dry w/ Gas Show	Columbian Carbon Co.	2930	Berea Sandstone
4707300183	1940	Dry	Columbian Carbon Co.	2930	Berea Sandstone
4707300192	1941	Dry w/ Oil Show	Faith Oil Co.	430	Buffalo Ss (Lit Dunkard)/1st Cow Run
4707300578	1959	Dry w/ O&G Show	Smellie & Myers	2527	Up Devonian undiff:Berea to Lo Huron
4707300588	1960	Dry	Daugherty, John	1217	Maxton
4707300611	1962	Dry w/ O&G Show	Quaker State Oil Refining Co.	1727	Berea Sandstone
4707300646	1968	Dry	Holton, Harry A.	5684	Salina
4707300682	1974	Gas	McDuff, Inc.	3297	Up Devonian undiff:Berea to Lo Huron
4707300684	1974	Gas	McDuff, Inc.	3179	Up Devonian undiff:Berea to Lo Huron
4707300913	1980	Oil and Gas	Haught, Inc.	3911	Lower Huron (undifferentiated)
4707300914	1980	Oil and Gas	Haught, Inc.	4011	Lower Huron (undifferentiated)
4707300915	1980	Oil and Gas	Haught, Inc.	4286	Lower Huron (undifferentiated)
4707300975	1980	Oil and Gas	Prior, Ferrell L.	3906	Java Formation
4707300976	1980	Oil and Gas	Prior, Ferrell L.	3646	Java Formation
4707300976	1989	Gas w/ Oil Show	Dupke, Roger	3646	Lower Huron (undifferentiated)
4707300996	1980	Oil and Gas	Prior, Ferrell L.	4129	Java Formation
4707301025	1980	Oil and Gas	Prior, Ferrell L.	3100	Lower Huron (undifferentiated)
4707301026	1981	Oil and Gas	Prior, Ferrell L.	3557	Lower Huron (undifferentiated)
4707301033	1980	Oil and Gas	Haught, Inc.	3990	Angola Formation
4707301087	1981	Oil and Gas	Prior, Ferrell L.	4050	Java Formation
4707301368	1981	Gas	Shafer Oil & Gas Corp.	4350	Rhinestreet Shale
4707301594	1983	Gas w/ Oil Show	Jenkins Energy Corp. & H. Davis Jenkins	4761	Rhinestreet Shale
4707301595	1983	Gas w/ Oil Show	Jenkins Energy Corp. & H. Davis Jenkins	4940	Rhinestreet Shale
4707301595	2011	not available	Ritchie Petroleum Corp., Inc.		
4707301596	1983	Gas w/ Oil Show	Jenkins Energy Corp. & H. Davis Jenkins	4769	Rhinestreet Shale

API #	Completion Year	Well Type	Operator	Total Depth (ft)	Deepest Formation
4707301597	1984	Dry w/ O&G Show	Stalnaker, Gene, Inc.	5059	Angola Formation
4707301604	1983	Oil and Gas	Jenkins Energy Corp. & H. Davis Jenkins	2038	Up Devonian undiff:Berea to Lo Huron
4707301630	1983	Dry w/ O&G Show	Stalnaker, Gene, Inc.	5050	Rhinestreet Shale
4707301635	1983	Dry w/ O&G Show	Stalnaker, Gene, Inc.	5060	Middlesex Shale
4707302514	2009	Gas w/ Oil Show	Patchwork Oil & Gas, LLC	2514	Up Devonian undiff:Berea to Lo Huron
4707302514	2009	Dry w/ Oil Show	Patchwork Oil & Gas, LLC	2125	Up Devonian undiff:Berea to Lo Huron
4707330089		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330090		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330113		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330115		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330127		not available	Faith Oil Co.		
4707330196		not available	Delong, J. R.		
4707330250		Oil and Gas	Oper in Min.owner fld,no code assgn(Orphan well proj)	884	Big Injun (undifferentiated)
4707330251		Oil and Gas	Oper in Min.owner fld,no code assgn(Orphan well proj)	820	Maxton
4707330258		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330270		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330271		not available	Oper in Min.owner fld,no code assgn(Orphan well proj)		
4707330593		not available	Dinsmoor & Co.		
4707330596		not available	Dinsmoor & Co.		
4707330597		not available	Dinsmoor & Co.		
4707330831		not available	Daugherty, John		
4707330885		not available	Daugherty, John		
4707331095		not available	WV Department of Mines, Oil & Gas Division		
4707331114		not available	Monongahela Power Company		
4707331115		not available	Monongahela Power Company		
4707331116		not available	Monongahela Power Company		
4707331117		not available	Monongahela Power Company		
4707331118		not available	Monongahela Power Company		
4707331119		not available	Monongahela Power Company		
4707331120		not available	Monongahela Power Company		
4707331121		not available	Monongahela Power Company		
4707331122		not available	Monongahela Power Company		
4707331123		not available	Monongahela Power Company		
4707331124		not available	Monongahela Power Company		

API #	Completion Year	Well Type	Operator	Total Depth (ft)	Deepest Formation
4707331125		not available	Monongahela Power Company		
4707331126		not available	Monongahela Power Company		
4707331127		not available	Monongahela Power Company		
4707331128		not available	Monongahela Power Company		
4707331129		not available	Monongahela Power Company		
4707331130		not available	Monongahela Power Company		
4707331131		not available	Monongahela Power Company		
4707331132		not available	Monongahela Power Company		
4707331133		not available	Monongahela Power Company		
4707331135		not available	Monongahela Power Company		
4707331136		not available	Monongahela Power Company		
4707331137		not available	Monongahela Power Company		
4707331138		not available	Monongahela Power Company		
4707331139		not available	Monongahela Power Company		
4707331141		not available	Lauderman Oil & Gas Drilling		
4707370016		not available	---------- unknown ----------		
4707370048		not available	Jennings Brothers, E. H., Company		
4707301119	1981	Dry w/ Gas Show	Vessel Resources Corp.	4000	Lower Huron (undifferentiated)
4707301606	1983	Gas w/ Oil Show	Beacon Resources Corp.	4110	Lower Huron (undifferentiated)
4707302524	2010		WVDEP Office Of Oil & Gas		
4707390126					
4707391316					

Note: Wells having API #s from 4707390041 through 4707390140 are also listed but have no associated information.

The completion dates for most of the wells are unknown, implying they were drilled as part of historic oil and gas well exploration in the area and potentially could have been drilled in the early 1900s or possibly in the late 1800s. A review of data for the other wells indicates they were drilled between 1935 and 2011. The total depths of the wells range from 71 ft to 5,684 ft and they've produced from formations including undifferentiated Upper Devonian Sandstone units. Many of the wells are reported as orphan wells and some have little or no information provided. As indicated on Figure 6, the wells are distributed across much of the site and adjoining areas. Considering the age of the wells there would seem to be potential for groundwater impacts from corroded/damaged well casing, degraded seals, etc., which could result in out-of-interval migration of oil and gas and formation brine. Any leaking oil and gas gathering lines/pipelines and wellhead brine storage tanks at currently producing locations could be another potential source of releases. As discussed further below, potential constituents known to be associated with oil and gas wells include barium, radium, chloride, sodium, lithium, and elevated TDS levels.

3.5.2 Occurrence of SSL Constituents in Oil and Gas Brines

It is noted in the "Chemistry and Origin of Oil and Gas Well Brines in Western Pennsylvania," (Dresel, P.E., and Rose, A.W., 2010) that brine samples collected from oil and gas operations indicate "…radium shows a general correlation with barium and strontium and an inverse correlation with sulfate." The data presented in Section 3.4, in which sulfate concentrations are inversely low compared to barium concentrations, supports this conclusion. The following table presents the range and mean concentrations reported in Dresel and Rose (2010) for applicable Appendix III/IV constituents in western Pennsylvania brines (assumed to be similar to those in West Virginia based on age and depositional environment):

	Dissolved Barium (mg/L)	Dissolved Chloride (mg/L)	Dissolved Lithium (mg/L)	Radium 226 (pCi/L)
No. of Brine Samples	33	40	33	6
Range	0.80 – 4,370	5,760 – 207,000	0.30 - 315	0 – 5,300
Mean	877.37	104,544	61	2,150

Based on these reported values, the following observations were made:

- **Barium -** The reported mean concentration of 877.37 mg/L is well above the UPL for upgradient well GW-7 (0.0934 mg/L). With respect to downgradient wells with SSLs for barium, the reported mean concentration of 877.37 mg/L is also well above the concentrations of barium in GW-23 (9.76212 mg/L), GW-24 (9.25331 mg/L), and GW-25 (7.62675 mg/L). However, brine impacts to those wells would be expected to be diluted by groundwater and, hence, a potential reason they are lower.
- **Chloride -** The reported mean concentration of 104,544 mg/L is three orders of magnitude greater than the UPL for upgradient well GW-7 (104 mg/L), and the reported minimum concentration of 5,760 mg/L is also higher than the GW-7 UPL. With respect to downgradient wells along the northern boundary with Appendix IV SSLs, the reported minimum chloride concentration in brines of 5,760 mg/L is below the concentrations of chloride in GW-23 (12,900 mg/L), GW-24 (8,520 mg/L), and GW-25 (7,110 mg/L)

indicating the groundwater in those wells is within the range of the minimum and maximum concentrations of chloride found in brine.

- **Lithium** – The reported mean concentration of 61 mg/L is significantly higher than the GW-7 UPL of 0.023374 mg/L. With respect to the downgradient well with an SSL for lithium, the reported mean concentration of 61 mg/L is higher than the concentration of lithium in GW-23 (0.150178 mg/L). However, brine impacts to GW-23 would also be expected to be diluted by groundwater and, hence, a potential reason they are lower.
- **Radium 226** – The reported mean concentration of 2,150 pCi/L is significantly higher than the GW-7 UPL of 0.58 pCi/L for the sum of both radium-226 and radium-228. With respect to downgradient wells with Appendix IV SSLs, the reported mean radium-226 concentration of 2,150 pCi/L in brine is higher than the concentration of radium-226 in GW-23 (23.6 pCi/L), GW-24 (12.7 pCi/L), and GW-25 (13.2 pCi/L). However, brine impacts to GW-23, GW-24, and GW-25 would also be expected to be diluted by groundwater and, hence, a potential reason they are lower.

An additional study regarding the occurrence of radium with oil and gas produced waters conducted by the USGS identified median radium concentrations of 2,460 pCi/L and 734 pCi/L, for Marcellus Shale and non-Marcellus Shale produced water samples, respectively (USGS, 2011). An increase in concentration of radium was directly correlated with increases in TDS and salinity of the produced water.

3.5.3 Previous Oil and Gas Impact Studies at the Site

In March 2004, Hydrosystems Management, Inc. (HMI) prepared a report for Allegheny Power Supply Company (a predecessor company of FirstEnergy) which evaluated increased barium concentrations in groundwater samples from monitoring well GW-4. GW-4 is part of the state Solid Waste/NPDES groundwater monitoring system, is located in the north-northeastern portion of the site (as shown on Figure 1), and has a total depth of 255 feet and a screen length of 55 feet. Barium concentrations in the well consistently exceeded the Ground-Water Quality Standard (GWQS) established in the facility's Solid Waste/NPDES permit. The HMI report concluded that leakage of brine from surrounding oil and gas wells was the most probable cause of the barium GWQS exceedances. GW-4 also showed increases in sodium and chloride levels. The HMI report indicated two known oil and gas wells were within 1,000 feet of GW-4 and referenced the existence of numerous orphaned wells in the area. As noted in Section 3.3 of this report, the boring log for GW-4 indicated oil and gas odors at the time of drilling; additionally, some oil associated with groundwater and oil sheen were both present during well installation and development.

In 2017, oil observed in GW-23 sample water was submitted for fingerprinting laboratory analysis to determine the exact oil type. Results of that fingerprinting analysis indicated that the oil from GW-23 was representative of a straight chain hydrocarbon mineral oil. This oil is likely a result of historical oil and gas exploration activities that have occurred in the area over the past 150 years. A copy of the fingerprinting analysis results is provided as Attachment B.

3.5.4 Historical Oil and Gas Activities in the Surrounding Area

Historical references regarding local oil and gas exploration activities in the Pleasants County area were also reviewed. In “A History of Pleasants County, West Virginia,” (Pemberton, 1929) the Burning Springs-Eureka anticline is noted as having its “ridge” eroded and exposing lower (older) strata with oil-bearing rocks located at or near the surface. Additionally, the First Cow Run sand mentioned in the text (from which oil and gas have been produced) is also known as the Saltsburg Sandstone, the formation in which numerous on-site wells have penetrated. Bearing more relevance to the site is the following anecdote:

> “Brown and Company of New York drilled in a well on McElroy Run back of Eureka on the Giles Hammett farm, which came to be known as the ‘Burnt Well,’ heretofore mentioned. At a depth of 1,100 feet a copious quantity of oil was found filling the hole to a depth of 100 feet. This was on April 27, 1886. A few days later the well was shot, and for a time flowed at a rate of forty barrels a day. Unfortunately, the rig caught fire, the cable was burned, and the heavy tools fell into the hole, where they remained about a year.”

The 1974 Environmental Impact Statement (EIS) (U.S. Army Engineer District, 1974) completed for the Pleasants Power Station noted that several oil and gas wells were drilled in 1958 and 1959 in the vicinity of the plant with one drilled to 740 feet producing 11 barrels of oil the first day. Four additional wells drilled to depths between 1,600 and 2,527 feet produced similar quantities of oil. It was stated in the EIS that “…it is presumed locally that these oil wells are those which have contaminated the water wells in the site area.”

In summary, the potential for impacts to groundwater by oil and gas wells on the site and in nearby upgradient areas appears to be significant, particularly in light of the historical and well-documented oil and gas well impacts in many of the groundwater monitoring wells located on-site. The data presented in this section indicate that the Appendix IV parameters barium and radium are likely attributable to oil and gas (brine) impacts. Lithium, which was reported at very high concentrations in oil and gas well brines for formations present at the site, may also be related to oil and gas brines, but since it is also present in site leachate at concentrations well above concentrations reported in the upgradient and downgradient CCR monitoring wells, it is not possible to clearly differentiate the source of lithium SSLs. However, as indicated by comparing the radium and barium isoconcentration maps (Figures 3 and 4, respectively) with the lithium isoconcentration map (Figure 5), the location of the highest concentrations for all three of these constituents occurs at GW-23, located along the northern property boundary, suggesting that lithium may exhibit a potential relationship with the barium and radium impacts from oil and gas well activities. Additionally, wells immediately downgradient of the leachate collection system along the western boundary (GW-27, GW-28, and GW-29) do not exhibit elevated concentrations of lithium, barium or radium, indicating that the presence of the three constituents in concentrations greater than their respective GWPS along the northern boundary are likely correlated and associated with oil and gas well impacts.

4.0 CERTIFICATION STATEMENT

In accordance with § 257.95(g)(3)(ii) of the CCR Rule, an ASD for Appendix IV constituents was undertaken for the CCR unit identified herein. Based on the information and data that were available for review, the following determinations have been made with respect to the AM-1, -2, and -3 events:

- The barium and radium SSLs can be attributed to historical and current oil and gas exploration and production activities that have occurred on-site. As such, in accordance with the applicable requirements of § 257.95 of the CCR rule, no corrective measures are required for these parameters and assessment monitoring for barium and radium will continue.
- The lithium SSLs are currently considered indeterminate based on the LOE's presented herein, but the available evidence indicates a high potential for the elevated lithium concentrations to also be attributable to oil and gas impacts at the site based on the occurrence of the barium, radium, and lithium concentrations above the GWPS occurring in the northern boundary in which extensive oil and gas activities have occurred historically. To resolve this uncertainty, the applicability of leachate and groundwater lithium isotopic analysis at the site will be evaluated and lithium sampling of brine from on-site production equipment will be considered. Pending completion of that work and for the purposes of this ASD, lithium has not been categorized as attributable to either the CCR unit or to an alternate source. It will continue to be analyzed as part of the assessment monitoring program and will transition to the applicable requirements of assessment of corrective measures per § 257.96 of the CCR Rule, should isotopic analysis and/or brine sampling indicate the CCR unit is the likely source of the lithium exceedances.
- The arsenic SSLs could not be attributed to sources other than the CCR unit, to errors in sampling, analysis, or statistical evaluation, or from natural variation in groundwater quality. As such, a transition to the applicable requirements of assessment of corrective measures for arsenic per § 257.96 of the CCR Rule appears to be warranted and assessment monitoring of this parameter will also continue.

5.0 REFERENCES

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TABLES

Table 1 - ASD Checklist 1: Sampling, Laboratory, or Statistical Causes

ASD Type	Potential Cause	Evaluation Summary
Sampling Causes (ASD Type I)	Sample mislabeling	No mislabeling found by comparing all COCs and lab data identifiers.
	Contamination	Field notes identified sheens and petroleum odors in GW-23 for Events 4 through 13, GW-24 for Events 6 through 13, and GW-25 for Events 4 through 6 (well was dry and not sampled in Events 7 through 10) and had odor in Events 11-13 when sampled again. Petroleum contamination could be a contributing factor for SSIs in these wells for Ba and Ra226 and 228.
	Sampling technique	HydraSleeves™ used instead of bladder pumps on some dates in wells GW-21 (upgradient), -23, -24, -25, and -26 due to limited available water.
	Turbidity	High turbidity (>10 NTU) in GW-19 (Events 1 and 2), GW-20 (Events 1, 4 through 11, and 13), GW-22 (Events 1 and 8 through 13), GW-24 (Event 12), GW-26 (Events 1 through 7), GW-28 (Event 1), and GW-29 (Event 1). When HydraSleeves™ used, turbidity not always reported. Turbidity may be a contributing factor to SSIs in GW-20.
	Sampling anomalies	Insufficient water for sampling in GW-21 (upgradient) for Events 5 through 10, GW-24 for Events 3 and 4, GW-25 for Events 1 and 7 through 10, and GW-26 for Events 8 through 12.
Laboratory Causes (ASD Type II)	Calibration	No comments on lab calibration in Data Validation Reports for Appendix IV parameters As, Ba, Li, or Ra226/228..
	Contamination	Barium detected in lab blank in Event 1, so GW-22 qualified “J” and in Event 8, but results >10X blank so no action taken. Arsenic detected in lab blank in Event 3, but all results >10X blank so no action taken. In Event 10, Ba was outside recovery range, so GW-27, -28, and -29 were qualified “J”. Arsenic detected in lab blank in Event 4, so GW-7, -9, and -27 qualified “U. In Event 7, Ra226 and 228 detected in lab blank, so GW-9, -19, and -26, GW-9 qualified “U”. In Event 8, Ra226 detected in lab blank, so GW-7 and its duplicate, GW-27, -28, and -29 qualified “U”. In Event 11, Ra228 detected in lab blank, but results for GW-23 and -24 were >10X blank or were non-detect. In Event 12, Ra226 detected in lab blank, so GW-7, -9, -20, -21 and its duplicate, GW-27, -28, and -29 qualified “U” but no action taken for GW-23, -24 and -25, since results were >10X blank; Ra228 also detected in lab blank, so GW-21 and its duplicate, and GW-27 qualified “U”. In Event 5 for Li, GW-24 qualified “J” due to conflicting directional bias. In Event 6, GW-27 was qualified “J” for Ra228 due to field imprecision.
	Digestion methods	No differences for Appendix IV parameters As, Ba, Li, and Ra226/228.
	Dilution corrections	Dilution factors in some events different for As and Ba between wells in the same event and for As for the same well in different events. Dilution factors high for As and Ba in some events in wells GW-7, -23, -24, and -25.
	Interference	Possible interference was noted in Data Validation Reports for Ra226 and 228 in Events 10 & 11. Barium carrier gas had radiation counts > limit, so Ra226 and 228 in GW-23 qualified “J” in Events 8, 10, 11, 12 and 13 and in Event 11, GW-24 also qualified “J”.
	Analytical methods	Methods same as in CCR GW Monitoring Plan for As, Ba, Li, and Ra226/228.
	Laboratory technique / qualifier flags	Had high recovery for MS/MSD for Ba in Event 1 (GW-20, -26, -27, and -29 and its duplicate). Had high recovery for MS/MSD for As in Event 4 (GW-23 and -22 and its duplicate). Had low recovery for MS/MSD for Li in Event 5 (GW-24). Had high recovery for LCS for Ra228 in Event 12 (GW-9 and -22). In Event 11, had low recoveries for MS/MSD for As with GW-19, -21, -24, -27 and its duplicate, GW-28, and -29) qualified “J” due to directional bias. Qualifier flags added appropriately.
	Transcription error(s)	None identified.
Statistical Evaluation Causes (ASD Type III)	Lack of statistical independence	Sampling interval was at least 4-5 weeks in upgradient wells GW-7 and -22 which are 2.5-inch and 4-inch diameter, respectively, wells in fractured bedrock, so not likely to be a concern. GW-7 was used as upgradient comparison well.
	Outliers	Possible outlier for Li identified in GW-23.
	False positives	In general, for the case of small sample sizes (e.g., n < 10-20), there is no mathematical algorithm to statistically prove a false positive result without resampling.
	Non-detect processing	Appendix IV parameters were non-detect in upgradient well GW-7 except for As, Ba, Li, and Ra226/228. In downgradient wells used for AM-1, AM-2 and AM-3, As, Ba, Li, and Ra226/228 detected in wells GW-9, -19, -20, -23, -24, -25, -26, -27, -28, and -29.
	Background data / change in normality	No new background data used for Assessment Monitoring (Events 11, 12, and 13).

Table 2 - ASD Checklist 2: Lines of Evidence Associated with the CCR Unit

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Primary CCR Indicators						
1a	If the CCR unit contains fly ash, is there an SSI/SSL for boron and sulfate?	Yes	CCR Release	Key	Monitoring Point	Northern Boundary: Boron SSIs in GW-19, -20, and -24; No Sulfate SSIs. Western Boundary: No Boron SSIs; Sulfate SSIs in GW-9, -27, and -29.
1b	If the CCR unit contains FGD gypsum (only) is there an SSI/SSL for sulfate?	Yes	CCR Release	Key	Monitoring Point	Northern Boundary: No. Western Boundary: Sulfate SSIs in GW-9, -27, and -29.
1c	Are there other constituents in the groundwater that represent primary indicators? List the applicable constituents.	Yes	CCR Release	Supporting	Monitoring Point	Northern Boundary: Calcium, Chloride, Fluoride, Lithium, and Molybdenum are all found at detectible levels in multiple downgradient monitoring wells. Western Boundary: Calcium, Chloride, Fluoride, Lithium, and Molybdenum are all found at detectible levels in multiple downgradient monitoring wells.
1d	Is there an SSI/SSL for any of the other primary indicators?	Yes	CCR Release	Key if No	Monitoring Point	Northern Boundary: Calcium (GW-23 and -24), Chloride (GW-19, -20, -23, and -24), Fluoride (GW-20), and Molybdenum (Gw-20, ,-24, and -25) have exhibited SSIs. Lithium is an SSI in GW-24 and an SSL in GW-23. Western Boundary: Calcium (GW-27, -28, and -29) and Chloride (GW-27, -28, and -29) have exhibited SSIs. Lithium has exhibited SSIs in GW-29; Molybdenum has exhibited SSIs in (GW-28).
1e	Is the leachate concentration for any of the primary indicators (including boron and sulfate) with an SSI/SSL statistically higher than background? List the applicable constituents.	Yes	CCR Release	Key if No	Constituent	Northern Boundary: Boron, Calcium, and Chloride – Yes; Fluoride - No. It is noted that statistical analysis has not been performed on leachate results; evaluation is based on four leachate sampling events conducted between October 2017 and April 2019. Western Boundary: Calcium, Chloride, and Sulfate – Yes. It is noted that statistical analysis has not been performed on leachate results; evaluation is based on four leachate sampling events conducted between October 2017 and April 2019.
1f	Are concentrations for the primary indicators increasing?	No	Uncertain	Supporting	Monitoring Point	Northern Boundary: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 year) for trend analysis. Western Boundary: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 year) for trend analysis.
Secondary Indicators						
2a	Are there other SSI(s) or SSL(s) of Appendix III or IV parameters?	Yes	CCR Release	Supporting	Monitoring Point	Northern Boundary: SSIs for pH (GW-23 and -24), TDS (GW-19, -20, -23, and -24), Barium (GW-19 and GW-20), Chromium (GW-20), Radium 226+228 (GW-9 and -19), and Selenium (GW-20); SSLs for Arsenic (GW-19, -23, -24, and -25), Barium (GW-23, -24, and -25), and Radium 226+228 (GW-9 and -19).

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Secondary Indicators (Continued)						
2a (con't)	(These are potential secondary indicators. List the applicable constituents.)					Western Boundary: SSIs for pH (GW-27, -28, and -29), TDS (GW-28 and -29), Barium (GW-27, -28, and -29), and Radium 226+228 (GW-27, -28, and -29); SSLs for Arsenic (GW-29).
2b	Are the constituents identified in 2a present in leachate in concentrations statistically higher than background?	Yes / No	Uncertain	Key if No	Constituent	Northern Boundary: pH, TDS, and Arsenic – Yes; Barium – No; Radium 226+228 not historically analyzed in leachate sampling program, but sampled once in July 2019 for this ASD. Statistical analysis has not been performed on leachate results; evaluation based on four sampling events conducted between October 2017 and April 2019 plus July 2019 sampling for Radium 226+228. Western Boundary: pH, TDS, and Arsenic – Yes; Barium – No; Radium 226+228 not historically analyzed in leachate sampling program, but sampled once in July 2019 for this ASD. Statistical analysis has not been performed on leachate results; evaluation based on four sampling events conducted between October 2017 and April 2019 plus July 2019 sampling for Radium 226+228.
2c	Are concentrations for any of the secondary indicators increasing? List the applicable constituents.	No	Uncertain	Supporting	Monitoring Point	Northern Boundary: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 years) for trend analysis. Western Boundary: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 years) for trend analysis.
Other Chemistry						
3a	Are organic constituents present in concentrations statistically higher than background?	N/A	-----	Supporting	Monitoring Point	Organics not analyzed as part of groundwater testing program at site.
3b	Is major ion chemistry similar to leachate?	ND	-----	Key	Monitoring Point	Based on primary and secondary indicator LOE's listed above, major chemistry analysis was not performed as part of Appendix IV ASD.
3c	Does major ion chemistry suggest a mixture of leachate and background groundwater?	ND	-----			Based on primary and secondary indicator LOE's listed above, major chemistry analysis was not performed as part of Appendix IV ASD.
3d	Does tritium age dating indicate that the groundwater was recharged after the facility was first used?	N/A	-----	Key if No	Monitoring Point	Disposal site development initiated in the late 1970's.
3e	Does isotopic analysis show evidence of mixing with CCR leachate?	ND	-----	Key	Monitoring Point	Based on primary and secondary indicator LOE's listed above, isotopic analysis was not performed as part of Appendix IV ASD.
Hydrogeology						
4a	Is the monitoring well with an SSI/SSL downgradient from CCR unit at any point during year?	Yes	CCR Release	Key if No	Monitoring Point	Multiple SSIs and SSLs were identified in the downgradient wells, all of which are positioned downgradient of the disposal site during all times of the year.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Hydrogeology (Continued)						
4b	Review the Hydrogeological vs Leachate Scenario Table (EPRI, Table A-2) and identify the most representative scenario for each SSI or SSL case. List cases and scenario numbers.	-----	-----	Key	Monitoring Point	**Northern Boundary** Boron - CCR Leachate Release (Row c) Calcium - CCR Leachate Release + Possible Alternative Source (Row b) Chloride - CCR Leachate Release + Possible Alternative Source (Row c) Fluoride – Alternative Source Release (Row b) pH – Alternative Source Release (Row a) TDS - CCR Leachate Release + Possible Alternative Source (Row b) Arsenic – CCR Leachate Release (Row c) Barium – Alternative Source Release (Row a) Chromium – Leachate data not available for comparison Lithium – CCR Leachate Release + Possible Alternative Source (Row c) Molybdenum – Leachate data not available for comparison Radium 226+228 - Alternative Source Release (Row a) Selenium – Leachate data not available for comparison **Western Boundary** Calcium - CCR Leachate Release (Row a) Chloride - CCR Leachate Release + Possible Alternative Source (Row b) pH – CCR Leachate Release (Row a) Sulfate - CCR Leachate Release (Row a) TDS - CCR Leachate Release (Row a) Arsenic – CCR Leachate Release (Row c) Barium – Alternative Source Release (Row a) Lithium – CCR Leachate Release + Possible Alternative Source (Row c) Molybdenum – Leachate data not available for comparison Radium 226+228 - Alternative Source Release (Row a)
4c	Is the CCR unit immediately underlain by clay, shale, or other geologic media with low hydraulic conductivity?	Varies	Uncertain	Supporting	Unit	Some areas of site are underlain by clayey colluvial soils, mostly along what were the lower portions of tributary valleys.
4d	Is the monitoring point distant from the facility AND does the constituent with an SSI/SSL have low mobility in groundwater given the hydrogeologic environment at the monitoring location (EPRI, Table A-3)?	No	CCR Release	Supporting	Case	All downgradient monitoring wells are located at the waste boundary except for GW-23 (Northern Boundary) and GW-9 (Western Boundary).

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Hydrogeology (Continued)						
4e	Are the background monitoring wells screened in the same hydrostratigraphic unit, and along the same groundwater flow path, as the monitoring location with the SSI?	No / Yes	CCR Release	Supporting	Monitoring Point	The CCR Rule-defined uppermost aquifer at the site is comprised of multiple water-bearing strata that are hydraulically connected. The site's upgradient well (GW-7) is located along the appropriate groundwater flow path to its corresponding downgradient wells, however, it is are also positioned stratigraphically higher than some of the downgradient wells.
CCR Unit Design						
5a	Does the entire footprint of the monitored CCR unit have a liner?	Yes / No	Potential Alternate Source / CCR Release	Supporting	Unit	The landfill area does have a liner system while the impoundment area (including the dam) does not.
5b	If the facility is lined, is it a composite liner?	Yes / No	Potential Alternate Source / CCR Release	Supporting	Unit	A portion of the landfill area is lined with only 24-inches of compacted clay, while the remainder utilizes a composite system comprised of a geosynthetic clay liner (GCL) overlain by a high density polyethylene (HDPE) geomembrane.
5c	Does the entire footprint of the CCR unit have a leachate collection system?	Yes / No	Potential Alternate Source / CCR Release	Supporting	Unit	The entire footprint of the landfill area does have a leachate collection system. The impoundment area does not have a leachate collection system, but the dam does include a blanket drain/chimney drain system.
5d	If the CCR unit is unlined, is it known to have or is it likely to have groundwater intersecting the CCR?	Yes	CCR Release	Supporting	Unit	Both the landfill and impoundment areas are situated within a valley (the impoundment at the head and the landfill at the mouth) and the CCR Rule-defined uppermost aquifer at the site is comprised of multiple water-bearing strata that are hydraulically connected. Most of the uppermost aquifer rock strata all outcropped within the valley before the disposal site was developed so it is very likely that groundwater intersects the CCRs, particularly in the impoundment area.

Table Notes:

1 ND (not determined) indicates that this line of evidence was not tested or there are insufficient data to make a determination; N/A means lines of evidence not applicable to the CCR unit.

2 Line of Evidence (LOE) Types:
Key lines of evidence are based on relationships that must be observed in order for an SSI/SSL to be due to a release from a CCR unit. If these relationships are not observed, then they are critical to establishing an ASD. It is difficult to build a strong ASD without any key lines of evidence. It may be possible to build an ASD with a single key line of evidence, but the ASD will be stronger with additional key or supporting lines of evidence.
Supporting lines of evidence provide additional information that supports the ASD. Supporting lines of evidence are generally not sufficient to build an ASD unless there is at least one key line of evidence, although it may be possible if there are many supporting lines of evidence.

3 This LOE applies to:
Constituent: An SSI/SSL for that constituent at any monitoring point
Monitoring Point: All SSIs/SSLs at a specific monitoring point
Case: An SSI/SSL for a specific constituent at a specific monitoring point
Unit: All SSIs/SSLs at the monitored unit

Table 3 - ASD Checklist 3: Lines of Evidence Associated with Alternative Natural and Anthropogenic Sources

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
General						
6a	Are there any known alternative sources for any of the constituents of concern on-site or off-site?	Yes	Potential Alternate Source	Supporting	Unit	Historical and current oil and gas exploration and production activities have the potential to cause brine water and associated constituents of concern to migrate into the monitored aquifer. Several hundred oil and gas wells dating back as far back as the late 1880s have the potential to have been improperly drilled, plugged, or produced, resulting in releases to the environment.
6b	Are any current or former potential alternative sources upgradient of the monitoring location?	Yes	Potential Alternate Source	Supporting	Monitoring Point	Historical and current oil and gas exploration and production activities have occurred in all areas surrounding the CCR unit, including areas upgradient/background of the monitoring locations.
6c	Do monitoring locations between a potential upgradient source and CCR unit have concentrations at SSI/SSL levels?	N/A	N/A	Supporting	Constituent	There are currently no monitoring locations situated between the potential upgradient sources and the CCR unit.
On-Site Alternative Source						
7a	Is the monitoring point downgradient of or near a coal pile, or coal pile runoff, or coal pile leachate management area?	No	No Alternate Source	Supporting	Monitoring Point	There are no coal pile, coal pile runoff, or coal pile leachate management areas near the downgradient monitoring points.
7b	Are there former coal mines, mine spoil, or conveyers near the CCR unit or upgradient from the facility?	No	No Alternate Source	Supporting	Unit	There are no known coal mining operations that have occurred on-site or in the surrounding area.
7c	Does the site have other CCR units that are upgradient or side gradient of the affected monitoring location?	No	No Alternate Source	Supporting	Monitoring Point	There are no other CCR units located upgradient or side gradient of the affected monitoring locations.
7d	Is the CCR unit built on top of a former CCR disposal area (i.e., has a lined impoundment been built on top of a former unlined impoundment, or has a lined landfill been built on top of a portion of an unlined impoundment)?	No	No Alternate Source	Supporting	Unit	The landfill area is lined (refer to Table 2, LOE 5b) and constructed atop the downstream face of the unlined impoundment's dam. However, the two disposal areas share a multi-unit groundwater monitoring network that does not allow for differentiation of impacts from one area or the other.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
On-Site Alternative Source (Continued)						
7e	Do the CCR unit or adjacent units have an active underdrain piping system or groundwater pumping system, or are there any groundwater pumping activities nearby, that could have localized influence on groundwater flow and quality?	Yes/No	No Alternate Source	Supporting	Unit	The entire footprint of the landfill area does have a combined groundwater underdrain/leak detection system and the impoundment dam has a blanket drain/chimney drain system. However, the impoundment area does not have any type of groundwater control system. As such, the landfill system is not expected to have a measurable localized influence on groundwater flow and quality.
7f	Is there evidence that water used for dust suppression on uncovered CCR or coal piles flowed off the footprint of the liner or runoff containment system near the monitoring point?	No	No Alternate Source	Supporting	Monitoring Point	There is no evidence of dust suppression water to have flowed off the footprint of the landfill liner or runoff containment systems and near the monitoring points.
7g	Is leachate or sluice water used for dust control close to the monitoring location?	No	No Alternate Source	Supporting	Monitoring Point	Dust control water is obtained from non-potable sources from the power station.
7h	Is the monitoring point downgradient of or near a CCR handling area (silo, storage area, dewatering bin, sump, truck loading/unloading or washing area, etc.) or haul road?	No/Yes	No Alternate Source/Potential Alternate Source	Supporting	Monitoring Point	Northern Boundary: No. Western Boundary: GW-27 and -28 are located near the CCR landfill haul road.
7i	Is the monitoring point downgradient of or near sluice water lines, handling equipment, or storage areas?	No/Yes	No Alternate Source/Potential Alternate Source	Supporting	Monitoring Point	Northern Boundary: No. Western Boundary: GW-27, -28, and -29 are positioned downgradient of the impoundment influent sluice line and effluent siphon line.
7j	Is the monitoring point downgradient of or close to a leachate collection pipeline or leachate storage structure?	No/Yes		Supporting	Monitoring Point	Northern Boundary: No. Western Boundary: GW-27 is located near the landfill's leachate collection and detection discharge lines.
7k	Have there been any documented spills of CCR or leachate or sluice water in upgradient or nearby locations?	No	No Alternate Source	Supporting	Monitoring Point	There are no known spills of CCRs, leachate, or sluice water in upgradient or nearby locations.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
On-Site Alternative Source (Continued)						
7l	Were CCRs ever drained or stockpiled in unlined areas and/or without run-off/leachate control in upgradient or nearby areas?	No	No Alternate Source	Supporting	Monitoring Point	All known CCR management activities at the site have been performed in the landfill or impoundment disposal areas..
7m	Is there any history of on-site or upgradient oil or chemical spills or leaking underground storage tanks?	Yes	Potential Alternate Source	Supporting	Monitoring Point	There are numerous historical and current oil and gas tank batteries and underground pipelines on the site with at least one known release from an oil pipeline that occurred near GW-7 approximately 15 years ago.
7n	Does a significant amount of road salting occur on-site? (also see 9b)	No	No Alternate Source	Supporting	Monitoring Point	The portion of the site access road that is paved and salted is located downgradient of the CCR unit monitoring wells.
7o	Are fertilizers being used on-site for cap vegetation or other uses?	Yes	Potential Alternate Source	Supporting	Monitoring Point	Fertilizers are used in the hydroseeding of all disturbed areas at the site (capped areas, borrow areas, etc.)
7p	Is there any history of on-site or background ash utilization (structural fill, landfill, road base, berm construction, soil stabilization, etc.)?	Yes	Potential Alternate Source	Supporting	Monitoring Point	The downstream portion of the impoundment dam is constructed of compacted fly ash and includes blanket and chimney drains that are constructed of bottom ash.
7q	Was the power plant site subgrade prepared with CCR, dredge spoils, incinerator residue, construction debris, industrial waste, or non-native soils?	N/A	N/A	Supporting	Monitoring Point	The Power Plant is located downgradient and distant from the CCR unit.
Natural Variation						
8a	Are background wells screened in the same geomedia as the monitoring point?	Yes/No	Potential Alternate Source/No Alternate Source	Supporting	Monitoring Point	The CCR Rule-defined uppermost aquifer at the site is comprised of multiple water-bearing strata that are hydraulically connected. The site's upgradient well (GW-7) and other background wells (GW-21 and -22) are located along the appropriate groundwater flow paths to the downgradient wells, however, it they are also positioned stratigraphically higher than some of the downgradient wells.
8b	Is the aquifer comprised of poorly buffered media such as sand and gravel?	No	No Alternate Source	Supporting	Unit	The aquifer is comprised of cyclic sequences of sandstone, shale, claystone, coal, and limestone and is not considered to be poorly buffered.
8c	Is the pH at the monitoring point similar to the background pH?	Varies	Uncertain	Supporting	Monitoring Point	The pH of the background well is typically moderately higher than the downgradient monitoring points.
8d	Is the monitoring point near a river?	No	No Alternate Source	Supporting	Monitoring Point	The Ohio River is located approximately 2000 feet downgradient of the closed CCR monitoring points (GW-9 and -19).

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Natural Variation (Continued)						
8e	Is the constituent chemically reactive in groundwater, such that dissolution or desorption is possible (EPRI, Table A-3)?	Yes/No	Potential Alternate Source/No Alternate Source	Supporting	Constituent	Arsenic: Reactive and influenced by pH and redox; sorption usually decreases with pH. Barium: Reactive; has limited solubility and is usually sorbed to clay, soils, and sediment. Lithium: Non-reactive. Radium: Reactive; subject to cation exchange.
8f	Is there a difference in redox indicators between background and compliance monitoring data?	ND	ND	Supporting	Monitoring Point	Redox parameters were not analyzed as part of the Appendix IV ASD.
8g	Has there been a recent flood, recharge event, or dry period that caused groundwater elevation to rise or fall to elevations higher or lower than observed during the background monitoring period?	No	No Alternate Source	Supporting	Unit	Groundwater conditions have generally remained consistent with changes not being attributable to flooding and drought conditions.
8h	Does the aquifer contain saline water at depth?	No	No Alternate Source	Supporting	Unit	Saline conditions are not observed in Site groundwater.
8i	Was the direction of groundwater flow prior to or during the sample event different than observed during the background prior?	No	No Alternate Source	Supporting	Monitoring Point	Groundwater flow has consistently been to the north and west and to the northeast for the western and northern boundaries, respectively.
Off-Site Anthropogenic						
9a	Are there former coal mines, mine spoil, or conveyers near the CCR unit or upgradient from the facility (also consider under "On-site")?	No	Uncertain	Supporting	Unit	There are no former coal mine, mine spoil, or conveyor systems upgradient of or near the CCR unit.
9b	Does a significant amount of road salting occur off-site?	N/A	N/A	Supporting	Unit	CCR unit is a captive site situated above the surrounding off-site roadways that are typically salted.
9c	Does the surrounding land use include agriculture (crops)?	Yes/No	No Alternate Source	Supporting	Unit	The neighboring properties appear to have limited agricultural uses (crops) which are determined to present little to no impacts to groundwater as it relates to the CCR unit.
9d	Does the surrounding land use include agriculture (animal)?	Yes/No	No Alternate Source	Supporting	Unit	The neighboring properties appear to have limited agricultural uses (animal) which are determined to present little to no impacts to groundwater as it relates to the CCR unit.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
Off-Site Anthropogenic (Continued)						
9e	Are there current or former underground or aboveground storage tanks that have had a release? (Consider gas stations and surrounding industrial activities.)	Yes	Potential Alternate Source	Supporting	Unit	There are numerous historical and current oil and gas production tank batteries surrounding the CCR unit. Documented spills from those tanks were not identified, but given the age of the tanks there is the potential that leaks and spills have resulted in impacts to groundwater.
9f	Are there, or were there, oil and gas production wells in the vicinity of the site?	Yes	Potential Alternate Source	Supporting	Unit	There are several hundred historical and existing oil and gas exploration and production wells on and in the vicinity of the site. Observations of oil and gas impacts to groundwater have been noted during the installation of several groundwater monitoring wells at the site and during groundwater sampling activities.
9g	Are there existing or historical commercial and/or industrial sources of impacts, such as metal manufacturing, mining, landfills, Superfund or brownfield sites, wood treatment, etc.?	No	No Alternate Source	Supporting	Unit	Other than the oil and gas activities discussed in LOE 9f, there are no other known historical off-site commercial and/or industrial sources.
9h	Could any potential anthropogenic sources be causing changes to groundwater chemistry that would result in release of the constituent of concern through changes to pH, redox, etc.?	Yes	Potential Alternate Source	Supporting	Unit	Historical and current oil and gas exploration and production activities have likely allowed for the migration of brine water and other constituents of interest in the overlying aquifer of the CCR unit that could be affecting groundwater geochemistry.
Time-of-Travel Analysis						
10	Has groundwater flowing beneath potential sources had enough time to migrate to the affected monitoring well location?	Yes	Potential Alternate Source	Supporting	Monitoring Point	Given the age of the CCR unit and history of disposal activities dating back to the late 1970s, there has been enough time for potentially impacted groundwater to flow to the affected monitoring wells.

Table Notes:

[1] ND (not determined) indicates that this line of evidence was not tested or there are insufficient data to make a determination; N/A means line of evidence not applicable to the CCR unit.

[2] Line of Evidence (LOE) Types:
Key lines of evidence are based on relationships that must be observed in order for an SSI/SSL to be due to a release from a CCR unit. If these relationships are not observed, then they are critical to establishing an ASD. It is difficult to build a strong ASD without any key lines of evidence. It may be possible to build an ASD with a single key line of evidence, but the ASD will be stronger with additional key or supporting lines of evidence.
Supporting lines of evidence provide additional information that supports the ASD. Supporting lines of evidence are generally not sufficient to build an ASD unless there is at least one key line of evidence, although it may be possible if there are many supporting lines of evidence.

[3] This LOE applies to:
Constituent: An SSI/SSL for that constituent at any monitoring point
Monitoring Point: All SSIs/SSLs at a specific monitoring point
Case: An SSI/SSL for a specific constituent at a specific monitoring point
Unit: All SSIs/SSLs at the monitored unit

Table 4 - Leachate Data Summary

	Leachate Concentrations (mg/L)				GW Concentrations (mg/L) Northern Boundary															
Parameters	LM1 Average	LM5 Average	LM7 Average	Leachate Avg.	UG UPL (GW-7)	GW-9	GW-19	GW-20	GW-23	GW-24	GW-25	GW-26	DG Avg.	Leachate Avg. > UG UPL?	DG Avg. > UG UPL?	GW-9 < Leachate Avg.?	GW-19 < Leachate Avg.?	GW-20 < Leachate Avg.?	GW-23 < Leachate Avg.?	GW-24 < Leachate Avg.?
Arsenic	0.055321	0.1667684	1.133410	0.451833	0.00682	0.00050	0.09721	0.00250	0.03248	0.02855	0.05652	0.03058	0.03548	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Barium	0.0204316	0.0233133	0.0344573	0.026067	0.0934	0.062755	1.10111	0.240567	9.76212	9.25331	7.62675	0.534738	4.08305	No	Yes	No	No	No	No	No
Lithium	3.29002	6.35006	4.26817	4.636083	0.023374	0.017431	0.014145	0.01607	0.150178	0.045126	0.030696	0.038631	0.04461	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Radium (226+228) (pCi/L)	0.5	1.81	0.0748	0.7949	0.58	ND	2.44	0.505	83.4	46.1	30.5	1.92	27.478	Yes	Yes	No	No	Yes	No	No

	Leachate Concentrations (mg/L)				GW Concentrations (mg/L) Western Boundary															
Parameters	LM1 Average	LM5 Average	LM7 Average	Leachate Avg.	UG UPL (GW-7)	GW-27	GW-28	GW-29					DG Avg.	Leachate Avg. > UG UPL?	DG Avg. > UG UPL?	GW-27 < Leachate Avg.?	GW-28 < Leachate Avg.?	GW-29 < Leachate Avg.?		
Arsenic	0.055321	0.1667684	1.133410	0.451833	0.00682	0.000352	0.005549	0.018564					0.00816	Yes	Yes	Yes	Yes	Yes		
Barium	0.020432	0.023313	0.034457	0.026067	0.0934	0.914027	0.249275	1.05644					0.73991	No	Yes	No	No	No		
Lithium	3.29002	6.35006	4.26817	4.636083	0.023374	0.013196	0.016578	0.033673					0.02115	Yes	No	Yes	Yes	Yes		
Radium (226+228) (pCi/L)	0.5	1.81	0.0748	0.7949	0.58	1.3	0.466	1.27					1.012	Yes	Yes	No	Yes	No		

Notes: DG -Downgradient; GW - Groundwater; UG - Upgradient; UPL - Upper Prediction Limit
Leachate Concentrations averaged from 5 sampling events performed between October 2017 and July 2019, except for Lithium and Radium which was from one event in July 2019.
GW Concentrations of App. III parameters from sampling and analysis completed in February 2019.
GW Concentrations of App. IV parameters from sampling and analysis completed in February 2019.
UG UPL's based on 8 baseline sampling events.

LM1 - Leachate Collection from Dam Blanket/Chimney Drains
LM5 - Stage 1G LCS
LM7 - Stage 2B LCS

FIGURES

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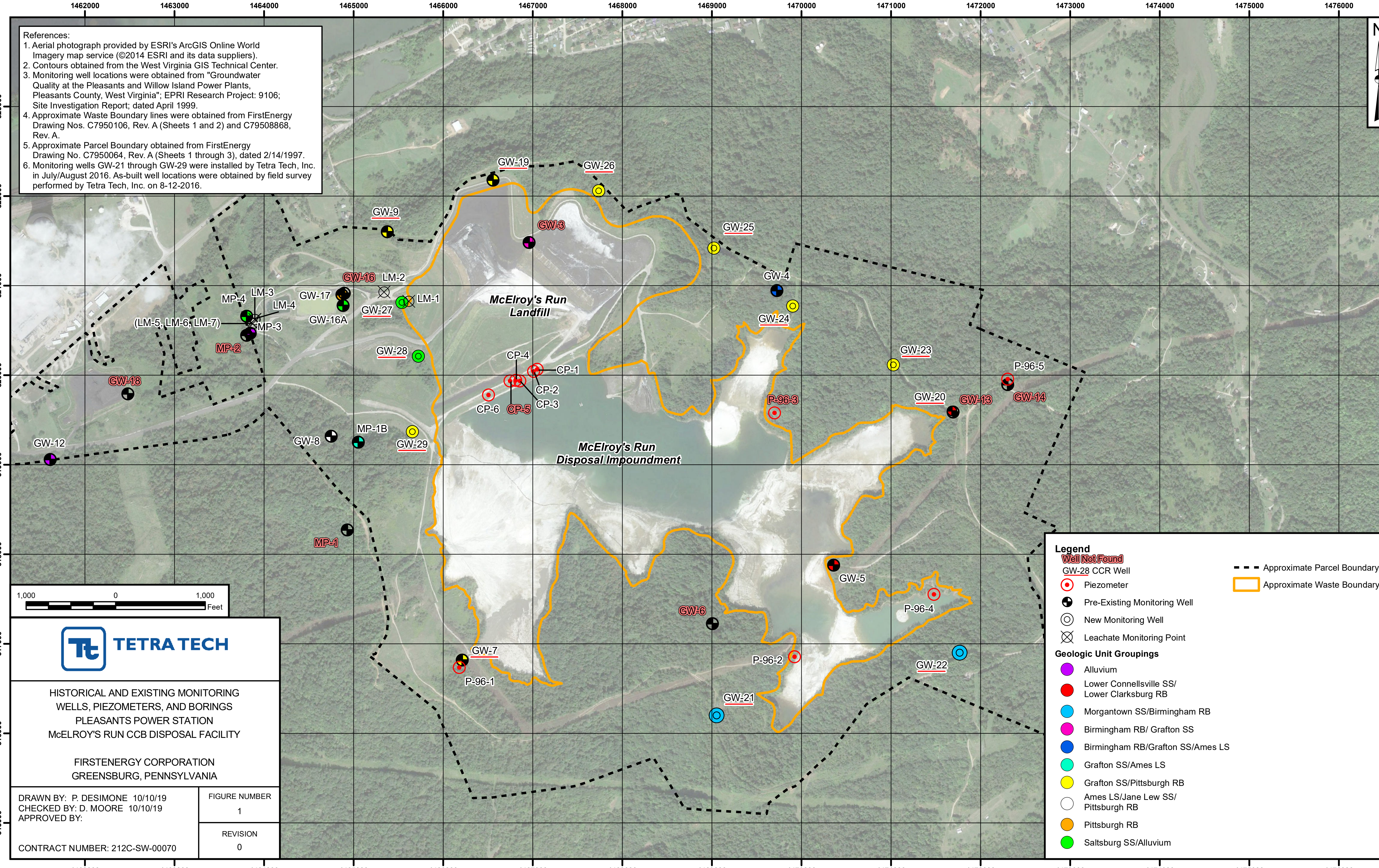

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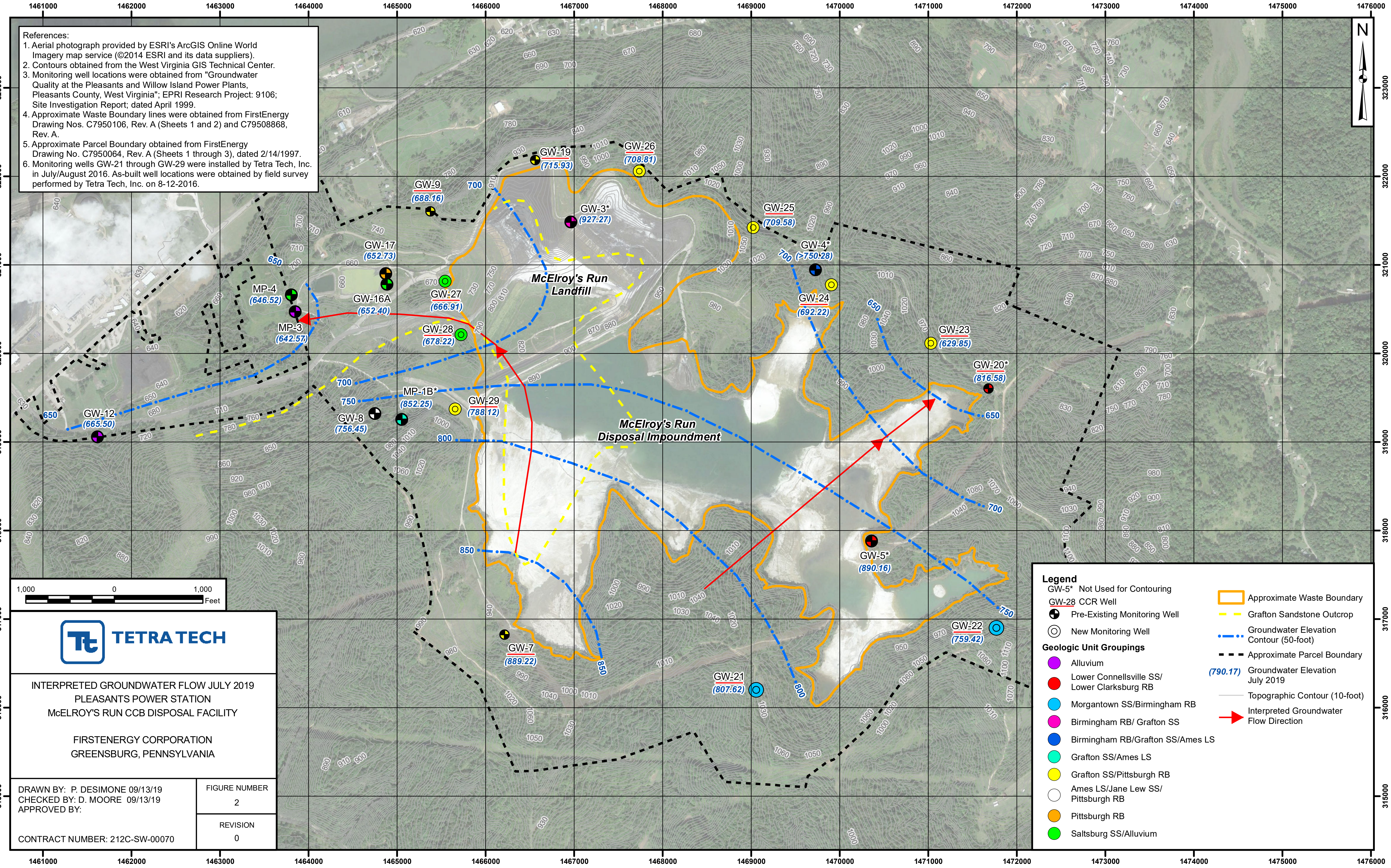

References:
1. Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (©2014 ESRI and its data suppliers).
2. Contours obtained from the West Virginia GIS Technical Center.
3. Monitoring well locations were obtained from "Groundwater Quality at the Pleasants and Willow Island Power Plants, Pleasants County, West Virginia"; EPRI Research Project: 9106; Site Investigation Report; dated April 1999.
4. Approximate Waste Boundary lines were obtained from FirstEnergy Drawing Nos. C7950106, Rev. A (Sheets 1 and 2) and C79508868, Rev. A.
5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C7950064, Rev. A (Sheets 1 through 3), dated 2/14/1997.
6. Monitoring wells GW-21 through GW-29 were installed by Tetra Tech, Inc. in July/August 2016. As-built well locations were obtained by field survey performed by Tetra Tech, Inc. on 8-12-2016.

Legend

- GW-5* Not Used for Contouring
- GW-28 CCR Well
- Pre-Existing Monitoring Well
- New Monitoring Well
- Approximate Waste Boundary
- Grafton Sandstone Outcrop
- Groundwater Elevation Contour (50-foot)
- Approximate Parcel Boundary
- (790.17) Groundwater Elevation July 2019
- Topographic Contour (10-foot)
- Interpreted Groundwater Flow Direction

Geologic Unit Groupings

- Alluvium
- Lower Connellsville SS/ Lower Clarksburg RB
- Morgantown SS/Birmingham RB
- Birmingham RB/ Grafton SS
- Birmingham RB/Grafton SS/Ames LS
- Grafton SS/Ames LS
- Grafton SS/Pittsburgh RB
- Ames LS/Jane Lew SS/ Pittsburgh RB
- Pittsburgh RB
- Saltsburg SS/Alluvium

TETRA TECH

INTERPRETED GROUNDWATER FLOW JULY 2019
PLEASANTS POWER STATION
McELROY'S RUN CCB DISPOSAL FACILITY

FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/13/19
CHECKED BY: D. MOORE 09/13/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00070

FIGURE NUMBER 2

REVISION 0

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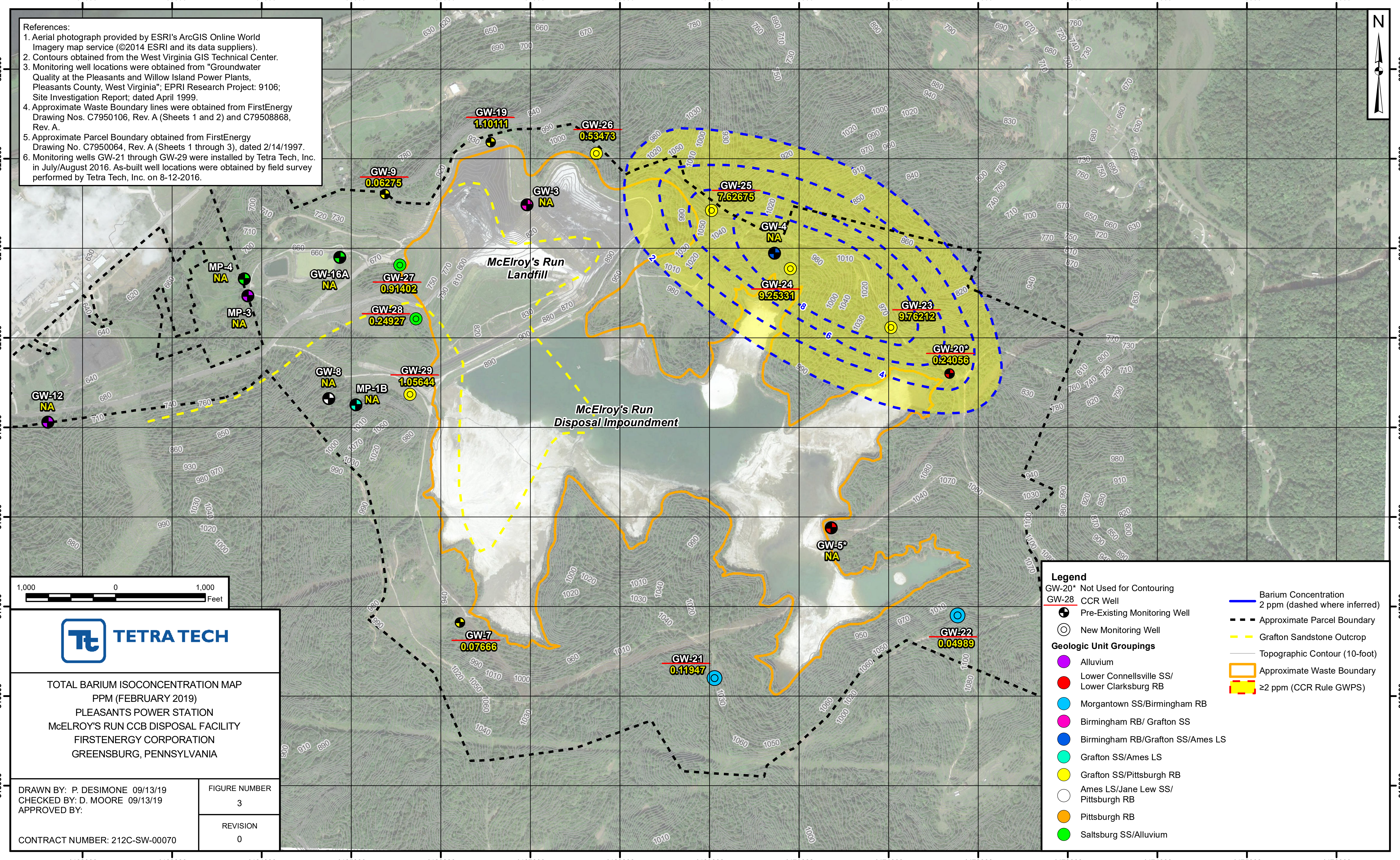

References:
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3. Monitoring well locations were obtained from "Groundwater Quality at the Pleasants and Willow Island Power Plants, Pleasants County, West Virginia"; EPRI Research Project: 9106; Site Investigation Report; dated April 1999.
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5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C7950064, Rev. A (Sheets 1 through 3), dated 2/14/1997.
6. Monitoring wells GW-21 through GW-29 were installed by Tetra Tech, Inc. in July/August 2016. As-built well locations were obtained by field survey performed by Tetra Tech, Inc. on 8-12-2016.

TETRA TECH

TOTAL BARIUM ISOCONCENTRATION MAP
PPM (FEBRUARY 2019)
PLEASANTS POWER STATION
McELROY'S RUN CCB DISPOSAL FACILITY
FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/13/19 CHECKED BY: D. MOORE 09/13/19 APPROVED BY:	FIGURE NUMBER 3
CONTRACT NUMBER: 212C-SW-00070	REVISION 0

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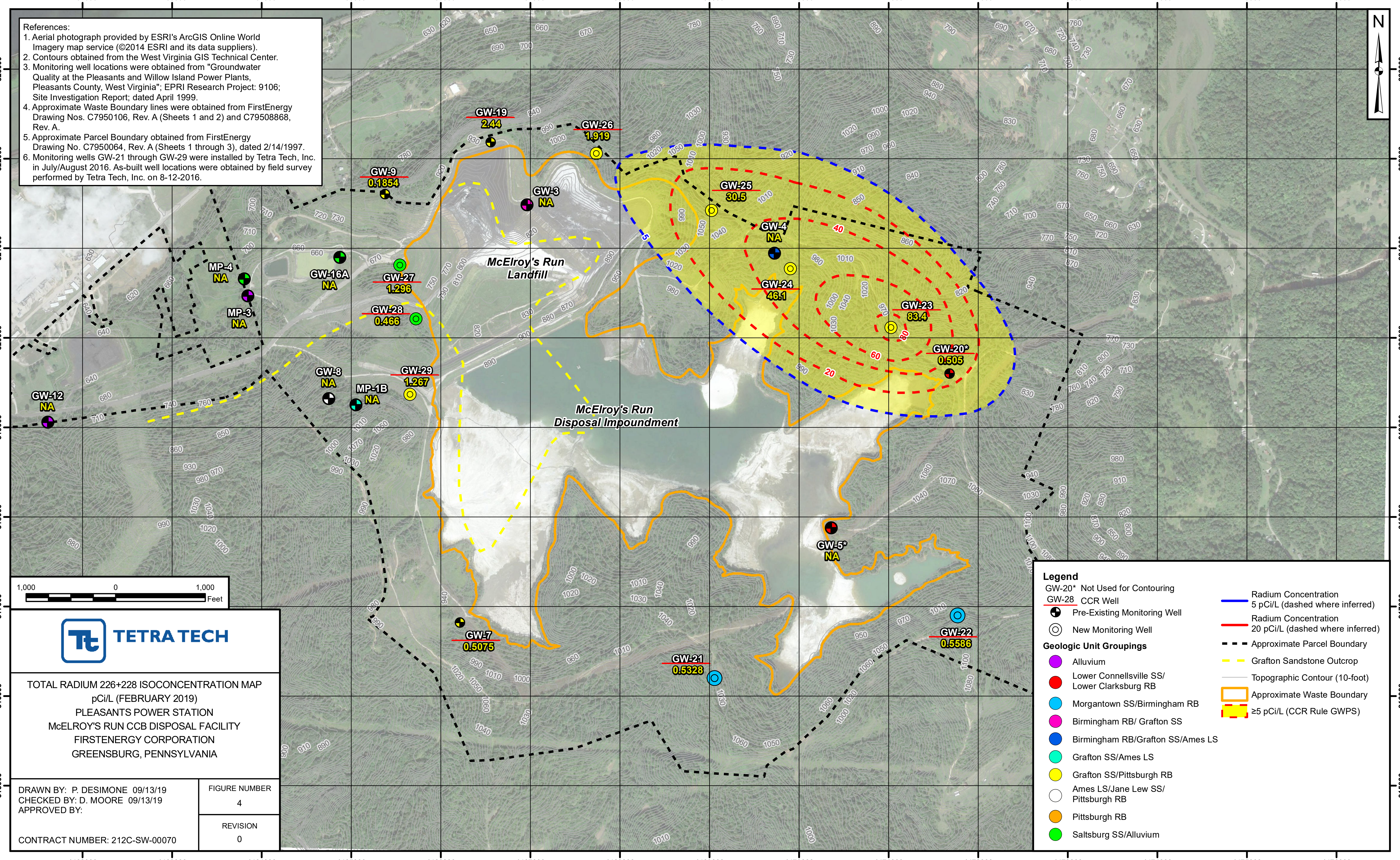

References:
1. Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (©2014 ESRI and its data suppliers).
2. Contours obtained from the West Virginia GIS Technical Center.
3. Monitoring well locations were obtained from "Groundwater Quality at the Pleasants and Willow Island Power Plants, Pleasants County, West Virginia"; EPRI Research Project: 9106; Site Investigation Report; dated April 1999.
4. Approximate Waste Boundary lines were obtained from FirstEnergy Drawing Nos. C7950106, Rev. A (Sheets 1 and 2) and C79508868, Rev. A.
5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C7950064, Rev. A (Sheets 1 through 3), dated 2/14/1997.
6. Monitoring wells GW-21 through GW-29 were installed by Tetra Tech, Inc. in July/August 2016. As-built well locations were obtained by field survey performed by Tetra Tech, Inc. on 8-12-2016.

Legend

- GW-20* Not Used for Contouring
- GW-28 CCR Well
- Pre-Existing Monitoring Well
- New Monitoring Well

Geologic Unit Groupings

- Alluvium
- Lower Connellsville SS/ Lower Clarksburg RB
- Morgantown SS/Birmingham RB
- Birmingham RB/ Grafton SS
- Birmingham RB/Grafton SS/Ames LS
- Grafton SS/Ames LS
- Grafton SS/Pittsburgh RB
- Ames LS/Jane Lew SS/ Pittsburgh RB
- Pittsburgh RB
- Saltsburg SS/Alluvium

- Radium Concentration 5 pCi/L (dashed where inferred)
- Radium Concentration 20 pCi/L (dashed where inferred)
- Approximate Parcel Boundary
- Grafton Sandstone Outcrop
- Topographic Contour (10-foot)
- Approximate Waste Boundary
- ≥5 pCi/L (CCR Rule GWPS)

TETRA TECH

TOTAL RADIUM 226+228 ISOCONCENTRATION MAP
pCi/L (FEBRUARY 2019)
PLEASANTS POWER STATION
McELROY'S RUN CCB DISPOSAL FACILITY
FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/13/19 CHECKED BY: D. MOORE 09/13/19 APPROVED BY:	FIGURE NUMBER 4
CONTRACT NUMBER: 212C-SW-00070	REVISION 0

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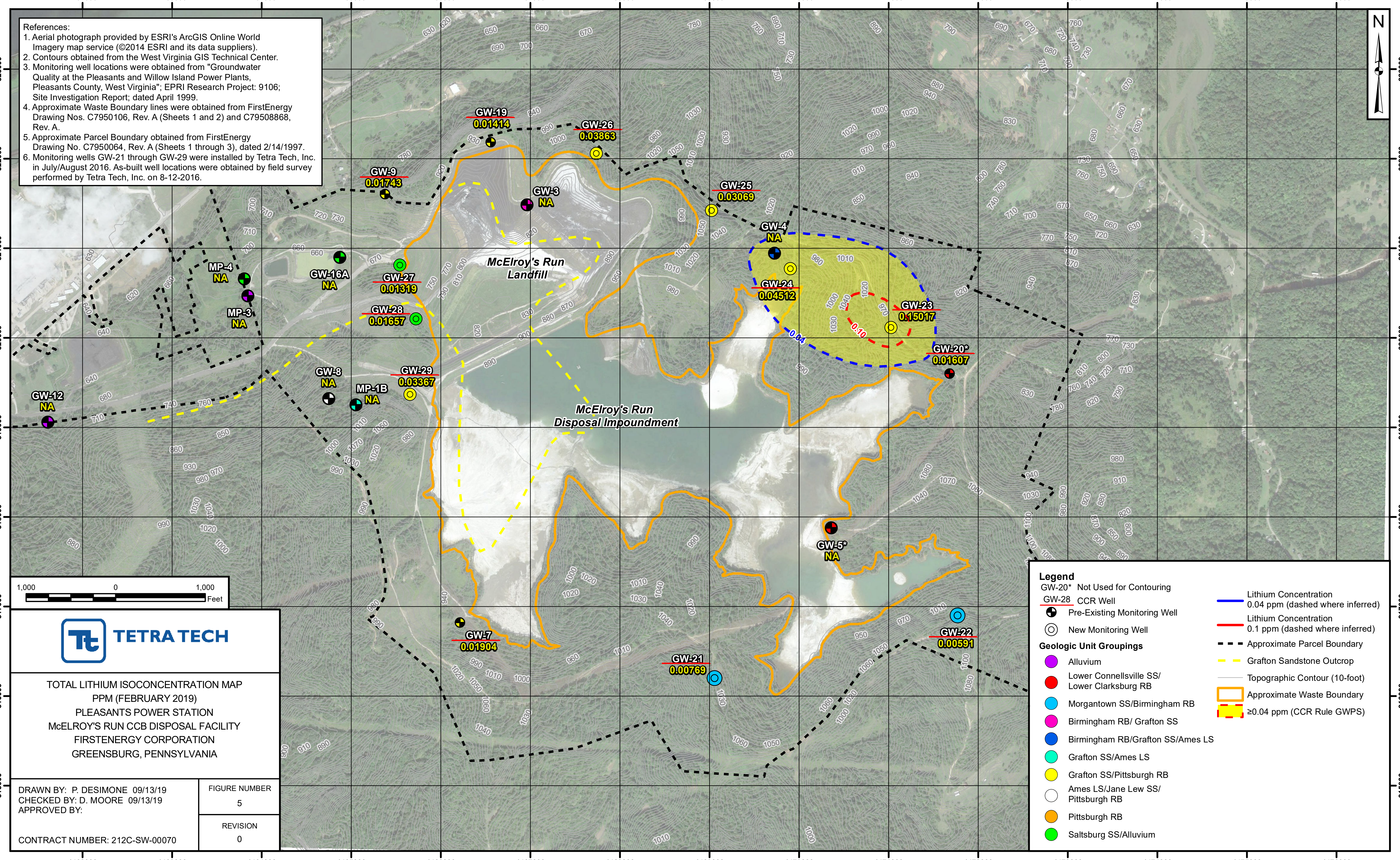

TETRA TECH

TOTAL LITHIUM ISOCONCENTRATION MAP
PPM (FEBRUARY 2019)
PLEASANTS POWER STATION
McELROY'S RUN CCB DISPOSAL FACILITY
FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/13/19
CHECKED BY: D. MOORE 09/13/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00070

FIGURE NUMBER 5

REVISION 0

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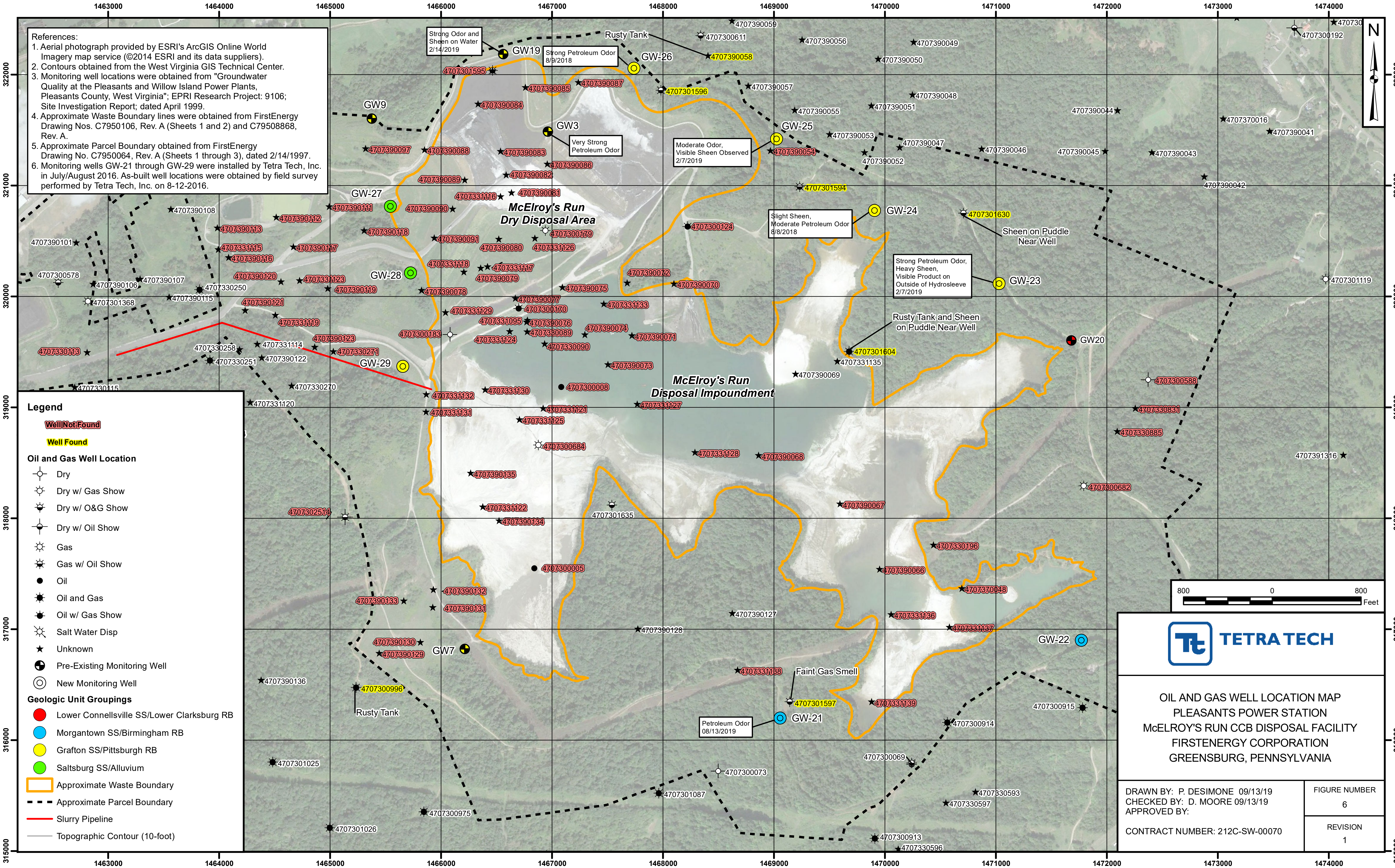


ATTACHMENT A

Boring Logs with Observations of Potential Oil and Gas Well Impacts

Figur 1.

CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

PROJECT: McElroys Run
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 9-2-93 thru 9-7-93 & 9-21-93
DATES INSTRUMENTED:

BOREHOLE NO.: GW-3
NORTH COORDINATE: 500,943.98
EAST COORDINATE: 2,346,506.67
SURFACE ELEVATION: 942.98
INSPECTOR: A. Caffas

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
0.0	3.0	Tan-Brn Silty Clay trace Dec. Shale					
3.0	12.0	Tan-Brn Dec. to Highly Weathered Silty Shale					
12.0	12.5	Red/Brn Clayey Shale					
12.5	26.0	Tan Highly Weathered to Dec. Silty Shale					
26.0	30.0	Tan-Gry Highly Weathered Shale					
30.0	38.0	Gry Silty Shale w/ Sandy Zones					Stopped @ 30.0' 9-2-93, Casing set to ~30.0' Resumed drilling 9-7-93 @ ~1030
38.0	40.0	Red w/ Gry Claystone					
40.0	41.0	Tan-Gry Fine grained Sandstone to Siltstone					
41.0	47.0	Tan Sandstone					Limy
47.0	50.0	Gry Siltstone					
50.0	51.0	Tan Siltstone					
51.0	52.0	Brn Sandstone					Moist
52.0	57.0	Tan & Gry Sandstone					
57.0	60.0	Gry Sandstone w/ Shale Partings					
60.0	69.0	Gry (w/ Tan-Brn Zones) Sandstone					Driller started adding water @ 61.0' (hole dry to 61.0') Iron Staining 65.0'-69.0'
69.0	73.0	Gry Interbedded Sandstone & Clayey Shale					Light Hydrocarbon odor
73.0	81.0	Gry Sandstone					Slightly limy cementation, weakly cemented sand particles Iron Staining 76.0'-80.0'
81.0	86.0	Gry Sandstone					Limy
86.0	90.0	DK Gry-BL Limestone & Sandstone					
90.0	95.0	Gry Sandstone					Limy

SUMMARY:

DRILLING (LF): ~~13 7/8"~~ 13 3/4" 30.0, ~~12 1/4"~~ 10 5/8" 235.0, 9 7/8" ____, 7 7/8" ____, 5 7/8" ____

CASING (LF): 12" 31.3, 10" ____, 8" ____, 6" ____

THERMOCOUPLE (LF): ____ GAS SAMPLING TUBE (LF): ____ INSTRUMENTATION: ____ CAP: ____

STANDBY TIME: ____ EXPLANATION: ____ *BOREHOLE NO.* GW-3

BOREHOLE SEAL: ____ EXPLANATION: ____

PAGE 1 of 3

REMARKS: Davey-Kent DR-30 Trackmounted Air Rotary Drill used to drill borehole.

Field Classification Sheet for Non-Sampled Borehole

Figur d.

PROJECT: McElroys Run Disposal Site
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 8/30 - 8/31/93
DATES INSTRUMENTED:

GAI CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

BOREHOLE NO.: GW-4
NORTH COORDINATE:
EAST COORDINATE:
SURFACE ELEVATION: ~ 920.0 Ft.
INSPECTOR: F. Lotito

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
0	14.5	Decomposed Tan Silty shale					- large Tan sandstone Fragments
14.5	20.0	Gray claystone					
20.0	23.0	Red silty shale					
23.0	24.0	Gray shale					
24.0	27.5	Gray Sandstone					
27.5	36.0	Gray and Gray/green shale					
36.0	37.0	Red shale					
37.0	38.5	Gray Sandstone					
38.5	40.0	Gray sandy shale					
40.0	58.0	Gray Sandstone					57.0' Hydrocarbon odor
58.0	60.0	Dk. Gray Claystone					
60.0	65.0	Gray Sandstone					
65.0	67.0	Lt. Gray Sandstone					Thin limestone layer between
67.0	75.0	Red/Brn. Claystone					65.0' - 74.0'
75.0	77.0	Dk. Gray Claystone					
77.0	82.0	Red/Brn. Claystone					stopped at 80.0' on 8-30-93
82.0	83.0	Limestone					started at 80.0' on 8-31-93
83.0	89.0	Red/Brn. Claystone/shale					
89.0	91.5	Blue/Gray Limy Claystone					
91.5	93.0	Red/Gray Limy Claystone					

SUMMARY:

DRILLING (LF): ~~13 7/8"~~ 13 3/4" 27.0, 12 1/4" ______, ~~9 7/8"~~ 10 5/8" 199.5, 7 7/8" ______, 5 7/8" ______

CASING (LF): ~~12"~~ 12 3/4" 28.5, 10" ______, 8" ______, 6" ______

THERMOCOUPLE (LF): ______ GAS SAMPLING TUBE (LF): ______ INSTRUMENTATION: ______ CAP: ______

STANDBY TIME: ______ EXPLANATION: ______ *BOREHOLE NO.* GW-4

BOREHOLE SEAL: ______ EXPLANATION: ______

PAGE 1 of 4

REMARKS: Lambert Drilling Co., Jim Crockett - Foreman, Nick Cursi - Driller, Helpers - Randy Kennedy, Bill Minor, Dale Myers, Aux: Davey Kent DR-30 Track-mounted Drill Rig

Field Classification Sheet for Non-Sampled Borehole

Figur[illegible] [illegible].

GAI CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

PROJECT: APS-McElroys Run
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 9/13-9/14/93
DATES INSTRUMENTED:

BOREHOLE NO.: GW-5
NORTH COORDINATE:
EAST COORDINATE:
SURFACE ELEVATION:
INSPECTOR: F.J. Lotito

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
130.0	133.0	Grey Clayshale					
133.0	134.0	Grey Fine-grained Sandstone					
134.0	136.5	Brn. Clayshale					~135.0' Hydrocarbon odor
136.5	138.0	Dark Grey Clayshale					
138.0	146.0	Red/Brn. Clayshale					
146.0	158.0	Grey to Grey/Red Clayshale					
158.0	159.0	Grey Silty Clayshale					
159.0	173.0	Grey Sandstone					
173.0	174.0	Grey Clayshale					
174.0	177.0	Grey Sandstone					
177.0	178.5	Grey Clayshale					
178.5	179.0	Grey Sandstone					
179.0	179.5	Grey Clayshale					
179.5	193.0	Grey Sandstone					~180.0' Excess water coming
193.0	199.0	Grey to Red/Brn. Clayshale					out of borehole, water
199.0	210.0	Grey Medium-grained Sandstone					has Hydrocarbon odor
210.0	213.0	Grey Clayshale					and sheen
213.0	214.0	Grey Sandstone					
214.0	215.0	Grey Clayshale					
215.0	240.0	Grey Sandstone					~225.0' Drilling resumed 0815 on 9/14, no water being added to air rotary, borehole producing alot of water.

SUMMARY:

DRILLING (LF): 13 7/8" ______, 12 1/4" ______, 9 7/8" ______, 7 7/8" ______, 5 7/8" ______

CASING (LF): 12" ______, 10" ______, 8" ______, 6" ______

THERMOCOUPLE (LF): ______ GAS SAMPLING TUBE (LF): ______ INSTRUMENTATION: ______ CAP: ______

STANDBY TIME: ______ EXPLANATION: ______ BOREHOLE NO. GW-5

BOREHOLE SEAL: ______ EXPLANATION: ______

PAGE 2 of 3

REMARKS: ______

Field Classification Sheet for Non-Sampled Borehole

Figur[illegible] 1.

PROJECT: APS - McElroys Run
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 9/23/93, 9/27/93
DATES INSTRUMENTED:

GAI CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

BOREHOLE NO.: GW-6
NORTH COORDINATE:
EAST COORDINATE:
SURFACE ELEVATION:
INSPECTOR: F.J. Lotito

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
112.0	114.5	Grey Shale					
114.5	118.0	Grey Sandstone					
118.0	120.0	Red/Brn Claystone					
120.0	121.0	Grey Shale					
121.0	140.0	Grey Fine-Med. grained Sandstone					
140.0	145.0	Grey Shale					
145.0	147.0	Grey Claystone					
147.0	168.0	Grey to Red/Brn Claystone					
168.0	169.0	Grey Silty Shale					Top of Grafton
169.0	172.0	Grey Fine-Med. grained Sandstone					
172.0	173.0	Red/Brn Claystone					
173.0	186.0	Grey Fine-Med. grained Sandstone					
186.0	190.0	Grey Shale to silty shale					
193.0	195.0	Grey Fine-Med. grained Sandstone					Blk. crude w/ cuttings & water
195.0	196.0	Grey/Red Silty Shale					~193.0 - 250.0'
196.0	198.0	Grey Sandstone					
198.0	207.0	Grey Siltstone					
207.0	210.0	Red/Brn. Siltstone					
210.0	214.0	Grey Siltstone					
214.0	221.0	Red/Brn Claystone					

SUMMARY:

DRILLING (LF): 13 7/8" ______, 12 1/4" ______, 9 7/8" ______, 7 7/8" ______, 5 7/8" ______

CASING (LF): 12" ______, 10" ______, 8" ______, 6" ______

THERMOCOUPLE (LF): ______ GAS SAMPLING TUBE (LF): ______ INSTRUMENTATION: ______ CAP: ______

STANDBY TIME: ______ EXPLANATION: ______

BOREHOLE NO. GW-6

BOREHOLE SEAL: ______ EXPLANATION: ______

PAGE 2 of 3

REMARKS: ______

Field Classification Sheet for Non-Sampled Borehole

.igu. d.

PROJECT: APS- McElroys Run
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 9/29/93
DATES INSTRUMENTED:

GAI CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

BOREHOLE NO.: GW-7
NORTH COORDINATE:
EAST COORDINATE:
SURFACE ELEVATION:
INSPECTOR: F.J. Lotito

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
0.0	20.0	Brn Silty Clay					
20.0	35.0	Brn Silty clay w/ Red/Grey Claystone					
35.0	38.0	Red/Brn silty clay					
38.0	42.0	Brn silty clay; Grey Sandstone 38-40.0'					
42.0	109.0	Grey and Red/Brn Claystone					
109.0	138.0	Grey Fine-Med. grained Sandstone					~114.0' Hydrocarbon odor, Black
138.0	146.0	Grey Claystone					Crude w/ cuttings
146.0	148.5	Grey Fine-Med. grained Sandstone					Top of Grafton 109.0'
148.5	150.0	Grey Sandy Siltstone					
150.0	153.5	Grey Fine-Med. grained Sandstone					
153.5	166.0	Grey Sandy Siltstone					
166.0	169.0	Grey Siltstone					
169.0	170.0	Brn. Fossiliferous Limestone					Ames LS

SUMMARY:

DRILLING (LF): ~~13 7/8"~~ 12 1/4" 20.0', ~~12 1/4"~~ 10 5/8" 150.0', 9 7/8" ____, 7 7/8" ____, 5 7/8" ____

CASING (LF): 12" 20.0', 10" ____, 8" ____, 6" ____

THERMOCOUPLE (LF): ____ GAS SAMPLING TUBE (LF): ____ INSTRUMENTATION: ____ CAP: ____

STANDBY TIME: ____ EXPLANATION: ____ BOREHOLE NO. GW-7

BOREHOLE SEAL: ____ EXPLANATION: ____ PAGE 1 of 2

REMARKS: Lambert Drilling Co., Davey-Kent DR-30 Track-mounted Drill Rig, Driller- Nick Cursi; Helpers- Randy Kennedy, Auz Kennedy

Field Classification Sheet for Non-Sampled Borehole

PROJECT: APS - McElroys Run
GAI PROJECT NO.: 81-237-44
CONTRACT NO.:
DATES DRILLED: 10/25/93
DATES INSTRUMENTED:

GAI CONSULTANTS, INC.

NON - SAMPLED BOREHOLE LOG

BOREHOLE NO.: GW-7
NORTH COORDINATE: 496,263.30
EAST COORDINATE: 2,345,907.90
SURFACE ELEVATION: 916.83
INSPECTOR: F. J. Lotito

DEPTH FROM	DEPTH TO	MATERIAL DESCRIPTION					REMARKS
0.0	6.0	Brn./Yellow Clay					
6.0	6.5	Brn. Clay w/ Grey Limestone nodules					
6.5	18.0	Red/Brn. and Brn./Yellow Clay					
18.0	22.0	Grey Sandy Shale					
22.0	30.0	Grey Fine-grained Sandstone					
30.0	39.0	Grey Silty Claystone					
39.0	40.0	Red/Brn Claystone					
40.0	45.0	Grey Claystone w/ Tan Cherty Limestone					
45.0	49.5	Grey Fine-grained Sandstone					
49.5	51.0	Grey Claystone					
51.0	53.0	Grey Fine-grained Sandstone w/ Cherty Matrix					
53.0	60.0	Grey Fine-grained Sandstone					
60.0	77.5	Grey Silty Claystone					~77.0' Blk. Natural Crude w/ odor
77.5	80.0	Dk. Grey Fossiliferous Limestone					Ames LS
80.0	84.0	Dk. Grey Limestone					
84.0	87.0	Blk. Coal					
87.0	99.0	Dk. Grey Claystone					
99.0	102.0	Grey Limestone					
		Bottom of Boring 102.0'					

SUMMARY:

DRILLING (LF): ~~13 7/8"~~ 13 3/4" 20.0', ~~12 1/4"~~ 10 5/8" 82.0', 9 7/8" ___, 7 7/8" ___, 5 7/8" ___

CASING (LF): ~~12"~~ 12 3/4" 19.5', 10" ___, 8" ___, 6" ___

THERMOCOUPLE (LF): ___ GAS SAMPLING TUBE (LF): ___ INSTRUMENTATION: ___ CAP: ___

STANDBY TIME: ___ EXPLANATION: ___

BOREHOLE SEAL: ___ EXPLANATION: ___

REMARKS:

BOREHOLE NO. GW-7

PAGE 1 of 1

CONSULTANTS, INC.

PROJECT APS- McELROYS RUN PROJECT NO. 81-237-66

ELEVATION 903.19 GWL 0 HRS 17' (AFTER HOLE PLUG) BORING NO. P-96-4

24 HRS 23'

DATE 5/20/96 FIELD ENGINEER RON ARCURI PAGE NO. 9 OF 16

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	PROFILE	SOIL DENSITY— CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
			9.8/10.0		MED. SOFT	GRAY	SILTSTONE	M	
		9.8/10.0					(CLAYSTONE 242.2'-243.3' & 243.7'-243.5')		
		98%	98%						
245.0				244.8	MED. SOFT	GRAY	SANDY SILTSTONE	M	
			10.0/10.0						
		10.0/10.0							
		100%	100%						
250.0									
				253.1	MED. HARD	GRAY	SANDSTONE	M	
255.0				254.3					
									RUN SMELLS LIKE OIL
			9.2/10.0						
		9.8/10.0							
		98%	92%						
260.0									
									ENDED DRILLING ON 5/20/96 AT 264.8'
265.0				264.8					
			10.0/10.0						
		10.0/10.0							
		100%	100%						
270.0									

REMARKS** HQ ROCK CORING WITH WATER

PROJECT NO. 81-237-66

BORING NO. P-96-4

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

GAI CONSULTANTS, INC.

PROJECT ALLEGHENY POWER - MCELROY'S RUN PROJECT NO. 81-237-72

ELEVATION ________ GWL 0 HRS ________ HRS ________ BORING NO. P-96-5

DATE 7 OCT 96 FIELD ENGINEER J.M. GALVIN PAGE NO. 14 OF 19

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
					MED HARD	GRAY	SILTSTONE	M	
399.8	◈								
400	10.0 / 10.0	100%	100						
404.8	◈								
				406.1					
				406.8			LIMESTONE (AMES)		FOSSILIFEROUS
					MED HARD		SILTSTONE		
410	10.0 / 10.0	100%	100						
				411.8					
					HARD		SANDSTONE (JANE LEW)		MID ∠ CLOSED
									FRACS AT 412.8,
414.8	◈								413.1 FT. MID ∠
									OPEN FRAC AT
									413.2, CRUDE
									OIL ODOR 411.8
									-442.6 FT
420	10.0 / 10.0	100%	100						

REMARKS** ________

PROJECT NO. 81-237-72

BORING NO. P-96-5

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

CONSULTANTS, INC.

PROJECT ALLEGHENY POWER - MCELROY'S RUN PROJECT NO. 81-237-72

ELEVATION ________ GWL 0 HRS ________ HRS ________ BORING NO. P-96-5

DATE 7 OCT 96 FIELD ENGINEER J.M. GALVIN PAGE NO. 15 OF 19

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
					HARD	GRAY	SANDSTONE (JANE LEW)	M	CRUDE OIL ODOR 411.8-442.6 FT
424.8									
									OPEN, MID TO LOW ∠ FRACS AT 430.9, 431.6, 432.7, 432.9, 436.4
430	10.0 / 10.0	100%	96						
434.8									
									CLAY FILLED HORIZ FRAC AT 437.8
440	10.0 / 10.0	100%	96						
				442.6					
					MED SOFT	RED + GRAY	CLAYSTONE (PITTSBURGH RED BEDS)	BR	MID ∠ OPEN FRAC AT 446.4 450.6 FT
444.8									
									WEATHERED ZONE AT 449.2 FT
450	10.0 / 10.0	100%	72						

REMARKS** ________

PROJECT NO. 81-237-72

BORING NO. P-96-5

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

PROJECT: McELROY'S RUN | BOREHOLE NO.: N-3 | NORTH COORDINATE: S 6384

GAI PROJECT NO.: 81-237-31 | DRILLING COMPANY: LAMBERT DRILLING CO. | EAST COORDINATE: E 9352

CONTRACT NO.: ______ | DRILL TYPE: ACKER AD-2 | SURFACE ELEVATION: 916.4

DATE STARTED: 7/26/90 | NAME OF DRILLER: DON REMERER | DEPTH OF HOLE: 414.8

DATE COMPLETED: 7/31/90 | CORE SIZE: NQ (2" DIAM.) | GWL @ COMPLETION: 12.3

SIGNATURE OF INSPECTOR: | NUMBER OF CORE BOXES: 28 | 24 HR 33.1

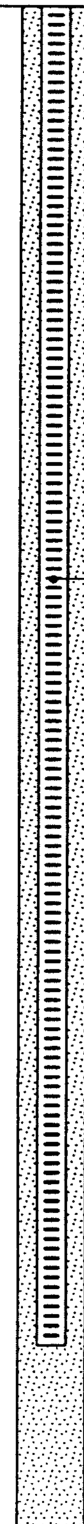
DRILLING DATA						ROCK DESCRIPTION				DISCONTINUITIES						REMARKS
DEPTH (FT.)	CORE BOX NO.	CORE RECOVERY (FT.)	CORE RUN (FT.)	CORE RECOVERY (%)	RQD (%)	COLOR	ROCK HARDNESS	MATERIAL CLASSIFICATION	ROCK BROKENNESS	TYPE	ORIENTATION	TIGHTNESS	DEGREE OF WEATHERING	FILLING MATERIAL	AVG. FRACTURE SPACING (FT.)	
400.0						GRAY	M.HARD-HARD	SANDSTONE — FINE GRAINED	MASSIVE							
404.6	27+28	10	10	100	100	GREEN/GRAY		404.6 SANDSTONE — FINE TO MEDIUM GRAINED								OILY ODOR
								408.0 OIL SEAM								SANDSTONE SEAM SATURATED WITH NATURAL CRUDE OIL. 408-410.6
410.0								410.6								
414.6								BOTTOM OF BORING EL. 501.8								

EPRI West Virginia Groundwater Study Allegheny Power System	**Log of Well GW-13** McElroy's Run Disposal Facility Pleasants/Willow Island Power Station	**Sheet 6 of 7** **JOB NUMBER:** 2008-202 **LOGGED BY:** G. Goldstein

Sample No./ Type	Sample Depth From/To	SPT (Blows/6")/ ROP (ft/min)	Recovery/ RQD (%)
20/NQ	193.5-203.5'	1.4	100/92
21/NQ	203.5-213.5'	0.6	100/96
22/NQ	213.5-223.5'	0.4	100/100
23/NQ	223.5-233.5'	1.6	100/82
24/NQ	233.5-243.5'		100/100

Depth (feet)	Materials Description
200	CLAYSTONE, 10 R 3/4, dark reddish brown, soft, weathered, highly fractured/faulted, not reactive to dilute HCL.
	CLAYSTONE, N3, dark gray, fresh soft, not reactive to dilute HCL.
205	CLAYEY SILTSTONE, N4, medium dark gray, soft, fresh, not reactive to dilute HCL.
	CLAYSTONE, 5 YR 4/1, brownish gray, soft, fresh, not reactive to dilute HCL.
	CLAYEY SILT, N4, medium dark gray, interbedded silt and clayey silt.
210	SANDSTONE, N5, medium gray, medium sand grain size, hard, fresh, with quartz, not reactive to dilute HCL. Crude oil odor.
215	SANDSTONE, 5 G 4/1, dark greenish gray, medium sand grain size, fresh, hard, with quartz and chlorite. 3" limey seam at 217' BGS. Visual crude oil staining, crude oil odor. 10" vertical fracture at 218.5' BGS.
220	
225	Same
230	CLAYSTONE, N4, medium dark gray, very soft, fresh, not reactive to dilute HCL.
	Same

Well Completion



cementation, and fracturing. In accordance with stress relief fracture theory, well yields are highest in the valleys, moderate on the hillsides, and minimal on the ridges (Shultz, 1984).

FIELD INVESTIGATION METHODS

Seven new monitoring wells (GW-13, GW-14, and GW-16 through GW-20) were installed for this study in 1995 (Figure 3-1). The wells were installed at locations where the bedrock aquifer has the potential for significant fracture development due to stress relief. In addition, ten existing monitoring wells were sampled for the study, and numerous boring logs from previous studies were available for geologic interpretation.

Monitoring wells GW-13, GW-14, and GW-20 are located on the east side of the McElroy's Run watershed. The wells were aligned along an eastward-trending transect identified as a potential groundwater flow path from the impoundment toward the neighboring French Creek watershed. The location of the transect coincides with small tributary valleys in the two watersheds. Wells GW-13 and GW-20 were installed as a cluster in order to investigate vertical gradients and water quality near the impoundment. Well GW-14 is located about 600 ft farther along the transect from the impoundment than the cluster. Boring GW-15 was drilled about 500 ft farther along the transect than GW-14. However, a thin layer (0.34 ft) of floating petroleum, analyzed as crude oil, was encountered in the borehole, and the borehole was abandoned.

Wells GW-16, GW-17, and GW-18 were installed in the valley bottom downstream from the impoundment dam. These three wells, along with existing wells MP-3 and MP-4, form a transect along the valley bottom from the dam to the Ohio River valley. Wells GW-16 and GW-17 were installed as a cluster to investigate vertical gradients and water quality near the toe of the dam. The MP-3/MP-4 well cluster is located approximately 1500 ft downgradient from the GW-16/17 cluster. MP-4 is installed in the shallow bedrock aquifer; MP-3 is an overburden well installed in the McElroy's Run valley alluvium. GW-18 is a bedrock well sited at the base of the McElroy's Run valley, near its junction with the Ohio River valley

Well GW-19 is located north of the impoundment. The well is aligned with pre-existing well GW-3 along a potential flow path through the ridge that separates the impoundment valley from the Ohio River.

Construction of these wells included coring, drilling, geophysical logging and packer testing. Each of these operations is summarized below. Additional detail is provided in Appendix A.

Log of Well GW-19

EPRI West Virginia Groundwater Study

Allegheny Power System

McElroy's Run Disposal Facility
Pleasant's/Willow Island Power Station

JOB NUMBER: 2008-202

LOGGED BY: G. Goldstein

Sample No./Type	Sample Depth From/To	SPT (Blows/6")/ROP (ft/min)	Recovery/RQD (%)
19/NQ	193.8-203.8'	1.4 1.2	100/87
20/NQ	203.8-213.8'	0.8	100/95
21/NQ	213.8-223.8'	0.8 0.6	100/25
22/NQ	223.8-233.8'	0.8	100/95
23/NQ	233.8-243.8'	1.2	100/95

Depth (feet)	Materials Description
198–203.8	CLAYSHALE, 5 G 6/1, greenish gray, hard, fresh, minor calcite viens, not reactive to dilute HCL. Horizontal fracture at 198.8' BGS.
203.8–208.3	CLAYEY SILTSTONE, N7, light gray, medium hardness, fresh, minor calcite, not reactive to dilute HCL.
208.3–213.8	SILTSTONE, N7, light gray, hard, fresh, not reactive to dilute HCL. Large fracture at 211.8' BGS ~1' long.
213.8–223.8	SANDSTONE, N6, medium light gray, fine to medium sand grain size, hard fresh, not reactive to dilute HCL. Crude oil odor. Series of fractures in bottom 5' of core.
223.8–233.8	SANDSTONE, N7, light gray, hard, fresh, small 3" clay seam at ~229' BGS, minor quartz, not reactive to dilute HCL. Crude oil odor.
233.8–	CLAYSTONE, N7, light gray, soft, fresh, few fossils, not reactive to dilute HCL.

Depth scale: 200, 205, 210, 215, 220, 225, 230

Well Completion

Filter Sand Pack from 193 to 239' BGS (Morie No. 3)

2" ID Schedule 40 PVC Screen

LOG OF BORING GW-24

Tetra Tech, Inc.
661 Andersen Dr
Pittsburgh, PA 15220

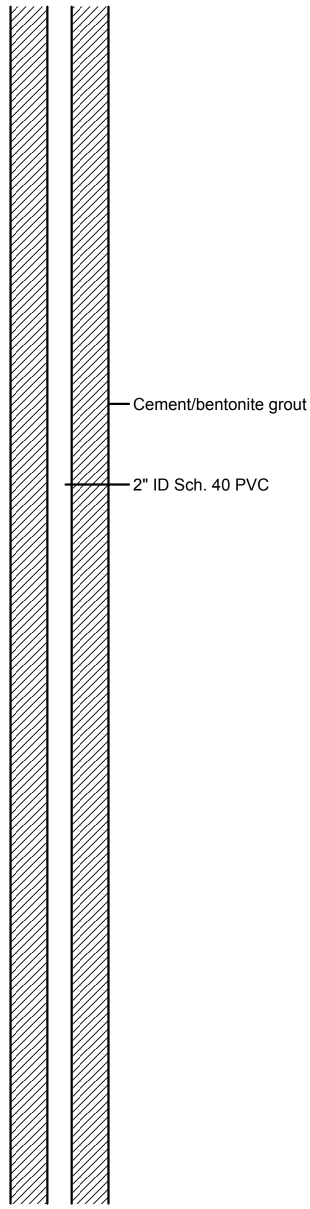
First Energy CCR, Pleasants Power

Project	: 212C-SW-00069	Drilling Contractor	: Eichelbergers
Site	: Pleasants Power	Logged By	: Scott Anderson
Date	: 7/12/16	Ground Elevation	: 944.56
Drilling Method	: Rotary Air Hammer	Driller	: Randy Hoffman
East	: 1469894.54	Northing	: 320797.11

Sample Type: Split Spoon; Air Hammer Drill Cuttings

Water Levels: ▼ During Drilling; ▽ After Completion

Depth in Feet	Sample Type	Rec. %	Blow Count	GRAPHIC	DESCRIPTION	USCS or Rock type
50						Sst
					Claystone, red/gray, soft No HCL Reaction	Clst
					Siltstone, green, soft No HCL reaction	Sltst
					Shale, red, soft No HCL reaction	Sh
60					Siltstone, green, soft No HCL reaction	Sltst
70						
					At 73 0.25 gpm water, hydrocarbon odor Sandstone w/Pyrite, green, hard	Sst
80					Siltstone to Sandstone, brown/red, soft No HCL reaction	Sltst
					Sandstone to Siltstone, green/gray, hard No HCL reaction	Sst
90					Shaley Siltstone, red, soft No HCL reaction	Sltst
100						



TETRA TECH

LOG OF BORING GW-25

Tetra Tech, Inc.
661 Andersen Dr
Pittsburgh, PA 15220

First Energy CCR, Pleasants Power

Project	: 212C-SW-00069	Drilling Contractor	: Eichelbergers
Site	: Pleasants Power	Logged By	: Scott Anderson
Date	: 7/25/16	Ground Elevation	: 1009.13
Drilling Method	: Rotary Air Hammer	Driller	: Randy Hoffman
East	: 1468884.46	Northing	: 321494.03

Sample Type: Split Spoon; Air Hammer Drill Cuttings

Water Levels: During Drilling; After Completion

Depth in Feet	Sample Type	Rec. %	Blow Count	GRAPHIC	DESCRIPTION	USCS or Rock type
200–204						Sst
204–208					Sandstone, Limestone, Shale, purple/red, hard	Sst
208–225					Limestone green/gray with Claystones red, soft Strong HCL reaction At 214-215 Claystone red At 216-216.5 Claystone red	LS
225–250					Very fine Sandstone green/gray and Siltstone, hard No HCL reaction At 230 Hydrocarbon odor Below 235, more Shaley Increasing Sandstone with depth to 250	Sst

Well construction: Cement/bentonite grout; Nominal hole dia. 6"; 2" ID Sch. 40 PVC

ATTACHMENT B

GW-23 Oil Fingerprinting Laboratory Report

FirstEnergy

BETA Laboratory
ISO 9001 Registered

File No. 17-95225

BETA Laboratory

Chemical Analysis

6670 Beta Dr., Mayfield Village OH 44143 (440)-604-9832

TO Edward Newbaker **MAIL STOP** G-CH **FROM** J. L. Hirsch **DATE** 4/28/17
PHONE 824-9832 **MAIL STOP** BETA
SUBJECT Analysis of oil floating on a Pleasants GW-23-CCR water sample

Requisition No.: 170428008
LSN# AK06089

A water sample from the Pleasants Ground Water 23-CCR location was submitted for water analysis but when the container was opened an oil film was present on the water's surface. The oil was extracted off the water and analyzed using a FT Infrared Spectrometer.

Results:

1) The oil was identified and a straight chain hydrocarbon oil (mineral oil).

Discussion:

The oil was extracted off the surface of the water using a dropper and the water was removed from the residue. The oil was then analyzed on the FT Infrared Spectrometer. ATTACHMENT 1 shows the results.

The FT Infrared Spectrometer was calibrated with Standard Reference Material (SRM)1921b, which is a matte finish polystyrene film certified by the National Institute of Standards and Technology (NIST). There was no Sample Analysis Request / Chain of Custody submitted for this analysis.

Material Test Equipment

Instrument Model: Perkin Elmer Frontier FT-IR Spectrometer, BETA 0755, Calibration Due: 5/4/17

Analysis Performed By J L Hirsch on 4/27/17

Reviewed By [signature] Date 4/28/17

ATTACHMENT 1: FTIR Spectrographic Analysis of the oil removed from the surface of the Pleasants GW-23-CCR water sample indicates the oil is a straight chain hydrocarbon mineral oil.
Instrument: Perkin Elmer Frontier FT-IR Spectrometer, BETA 0755, Calibration due 5/4/17
Performed by J. Hirsch on 4/27/17