CCR RULE ASSESSMENT OF CORRECTIVE MEASURES (ACM) REPORT

COAL COMBUSTION BYPRODUCT LANDFILL

Hatfield's Ferry Power Station
Greene County, Pennsylvania

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Tetra Tech Project No. 212C-SW-00071

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ACRONYMS/ABBREVIATIONS

ACM	Assessment of Corrective Measures
AGWMCA	Annual Groundwater Monitoring and Corrective Action
AM	Assessment Monitoring
ASD	Alternate Source Demonstration
bgs	Below ground surface
CCBL	Coal Combustion Byproduct Landfill
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
DM	Detection Monitoring
FE	FirstEnergy Generation
gpm	Gallons Per Minute
GWPS	Groundwater Protection Standard
K	hydraulic conductivity
mg	milligrams
mg/L	milligrams per liter
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MW	Megawatt
msl	Mean sea level
N&E	Nature and Extent of Release
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PADEP	Pennsylvania Department of Environmental Protection
POC	point of compliance
PZ	Piezeometer
PRB	Permeable Reactive Barrier
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SoR	Selection of Remedy
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
Station	Hatfield's Ferry Power Station
TDS	total dissolved solids
Tetra Tech	Tetra Tech, Inc.
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
ZVI	Zero Valent Iron

1.0 INTRODUCTION

This Assessment of Corrective Measures (ACM) Interim Report was prepared by Tetra Tech, Inc. (Tetra Tech) on behalf of FirstEnergy Generation (FE) for the Coal Combustion Byproduct Landfill ("CCBL", "CCR unit", or "Site") at the deactivated Hatfield's Ferry Power Station (hereinafter referred to as the "Station"). The Station is located in Monongahela Township, Greene County, Pennsylvania (Figure 1-1). This report was developed to comply with pertinent requirements of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals (CCR) Rule, specifically the Assessment of Corrective Measures requirements per 40 CFR § 257.96.

As discussed further below, CCR Rule groundwater Assessment Monitoring (AM) conducted at the Site identified lithium concentrations in certain downgradient CCR monitoring wells which were at Statistically Significant Levels (SSLs) that exceeded the Groundwater Protection Standard (GWPS) for lithium, resulting in the need to conduct an Assessment of Corrective Measures per 40 CFR § 257.96.

1.1 PURPOSE

The purpose of this ACM Interim Report is to provide the following: background on groundwater monitoring findings leading to the ACM; an overview of potential corrective measures which were evaluated; and a comparative evaluation of the corrective measures with regard to the pertinent CCR Rule criteria. In addition, the report specifies the path for meeting Selection of Remedy (SoR) requirements of the CCR Rule (per 40 CFR § 257.97). The assessment of corrective measures has included developing and evaluating new field and laboratory information and data as well as reviewing historical field and laboratory information and data developed by other professional engineers and geologists. In preparing this report, Tetra Tech has exercised its professional judgement in accordance with generally accepted engineering and geology principles and practices to identify and assess the range of potential corrective measures described herein.

1.2 REGULATORY REQUIREMENTS

Initiating and Completing an Assessment of Corrective Measures

40 CFR§ 257.96(a) requires that within 90 days of finding that any constituent listed in Appendix IV has been detected at a SSL exceeding the GWPS or immediately upon detection of a release from a CCR unit, the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases, and to restore affected areas to original conditions. The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances. The 90-day deadline to complete the assessment of corrective measures may be extended for no longer than 60 days.

Characterizing the Nature and Extent of Release

Following identification that one or more Appendix IV constituents has been detected at a SSL exceeding the GWPS, the owner or operator of the CCR unit must also:

(1) Characterize the nature and extent of the release (N&E) and any relevant site conditions that may affect the remedy ultimately selected. The characterization must be sufficient to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from the CCR unit pursuant to § 257.96. Characterization of the release includes the following minimum measures:

(i) Install additional monitoring wells as necessary to define the contaminant plume(s);

(ii) Collect data on the nature and estimated quantity of material released including specific information on the constituents listed in Appendix IV and the levels at which they are present in the material released;

(iii) Install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with 40 CFR 257.95(d)(1) ; and

(iv) Sample all wells in accordance with 40 CFR 257.95(d)(1) to characterize the nature and extent of the release.

The following summarizes the timeline pertaining to compliance at the Site with the above CCR Rule requirements:

- February 13, 2019 (Revised April 5, 2019) - Pursuant to 40 CFR 257.95(g) and 257.105(h)(8), FE provided notification in the Operating Record that the 2018 groundwater Assessment Monitoring (AM) program at the Site had identified lithium and cobalt concentrations detected at SSLs above their respective GWPSs established as per 40 CFR 257.95(h). Also, at that time, FE initiated activities to characterize the nature and extent of release. The notification was posted to the publicly accessible website on April 5, 2019.
- April 15, 2019 - Pursuant to 40 CFR 257.95(g)(3)(i) and 257.105(h)(9), FE provided notification in the Operating Record that an Assessment of Corrective Measures (ACM) had been initiated for lithium and cobalt in groundwater at the Site. The notification was posted to the publicly accessible website on June 12, 2019.
- July 15, 2019 - Pursuant to 40 CFR 257.96(a), FE provided in the Operating Record a demonstration that, based on hydraulic characteristics of the uppermost aquifer, an additional 60 days was required to complete the ACM.

This document was developed to meet requirements of 40 CFR § 257.96(c), which states the following:

"The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under § 257.97 addressing at least the following:

(1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) The time required to begin and complete the remedy;

(3) The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s)."

1.3 SITE BACKGROUND

CCRs produced at the Station were placed in the facility's captive CCBL, which is located approximately one mile west-southwest of the Station. The landfill is an existing CCR unit that is regulated under Pennsylvania Department of Environmental Protection (PADEP) Solid Waste Permit No. 300370. A PADEP groundwater monitoring program for the landfill has been in effect since 1993 and a separate CCR Rule groundwater monitoring program has been in effect since 2017. Although CCR waste generation ceased when the Station closed in 2013, a September 2015 modification to the permit also allowed coal combustion wastes generated at other FirstEnergy facilities to be disposed at the Hatfield CCBL. However, no disposal from any other facilities has occurred to date.

The original topography of the CCBL area has been altered by surface mining of coal (primarily Waynesburg seam) that was performed during the 1970s and 1980s throughout much of the central portion of the site. Mine spoil, in some cases mixed with fly ash, was used as backfill for mined areas. As shown on Figure 1-1, the CCBL consists of three permitted disposal areas: Phase I (approximately 11 acres), Phase II (approximately 20 acres), and Phase III (approximately 107 acres at full build-out). The Phase I and II areas are unlined but do include an underdrain blanket system and are largely overlain by the Phase III area, which has a Pennsylvania Class I Residual Solid Waste liner system that includes two geomembranes, a geosynthetic clay liner (GCL), a leachate collection system, and a leak detection zone. Disposal operations were performed in the Phase I and II areas until 2010, at which time all operations were transitioned to the Phase III area. Between 2009 and 2013, the Phase III area was constructed in stages (referred to as "Steps"): Steps 1, 2, and 3-1, which have a combined lined area of approximately 58 acres. Underdrain flows collected from the Phase I and II areas are routed to two concrete sumps where they are then pumped to a passive wetland treatment system located northeast of the Phase II disposal area. Discharges from the treatment wetlands flow by gravity into a stormwater control pond that discharges off-site. Surface water runoff and leachate collected from the Phase III area are routed to the landfill's Leachate Storage Impoundment (LSI), which is located east of the Phase II and Phase III disposal areas. Like the Phase III area, the LSI has a Class I liner system.

Groundwater in the CCBL area occurs primarily within the mine spoil and underlying fractured bedrock and flow is primarily controlled by topography and by the bedrock structure (i.e., dip). The uppermost aquifer in the CCBL area is the mine spoil/weathered bedrock aquifer (shallow aquifer) but some of the shallow groundwater also migrates to the underlying Uniontown sandstone aquifer. Historic and recent groundwater level data indicate groundwater flow within the mine spoil/weathered bedrock aquifer is primarily to the north along the slope of the top of bedrock. A portion of the shallow groundwater in the eastern portion of the CCBL (northeast of the waste boundary) also flows eastward. A representative set of water level data from the time period of this ACM (July 2019) were used for contouring groundwater flow patterns at the site in both the Mine Spoil/weathered bedrock and Uniontown Sandstone aquifers as shown on Figures 1-2 and 1-3, respectively. These water levels were very similar to historical levels across the site, which exhibit very little seasonal and temporal fluctuations. As such, separate mapping for other time periods was not necessary for this report. A more detailed discussion of the site's geologic and hydrogeologic characteristics can be found in Section 4.0 of this report.

As detailed in the CCR unit's most recent Annual CCR Groundwater Monitoring and Corrective Action Report ("2018 AGWMCA Report", accessible at http://ccrdocs.firstenergycorp.com/), the certified CCR monitoring well network consists of three upgradient (background) wells in the mine spoil/bedrock aquifer (MW-212A, -213A, and -215A), one upgradient (background) well in the Uniontown sandstone aquifer (MW-212B), five downgradient wells to monitor the combined aquifer (MW-216A, -220A, -202B, -203B, and -204B), and one piezometer (PZ-221A), as shown on Figure 1-1. It is noted there is also a groundwater monitoring well network at the Site associated with the state solid waste permit, and these wells are also shown on Figures 1-1, 1-2, and 1-3. As discussed in Section 3.0, some of the state network wells were added to the monitoring program for the N&E characterization since they were strategically located upgradient and downgradient of the CCR waste boundary wells and are screened in the same monitored aquifer system(s).

1.4 OVERVIEW OF REPORT CONTENTS

Section 1.0 of this report provided an overview of the CCR ACM regulatory requirements and background on the CCR unit and CCR groundwater monitoring well network. Section 2.0 summarizes Detection and Assessment Monitoring results as well as the findings of the Appendix III ASD and Appendix IV ASD. Section 3.0 summarizes the Nature and Extent of Release Characterization. Section 4.0 presents the Conceptual Site Model (CSM). Section 5.0 provides the identification and screening of remediation

technologies to address lithium SSLs in groundwater, and Section 6.0 presents the assessment of corrective measures by comparing the candidate technologies to ACM criteria in 40 CFR § 257.96(c). Section 7.0 summarizes the Selection of Remedy (SoR) process. Section 8.0 provides references for documents cited in this report.

2.0 GROUNDWATER MONITORING RESULTS

This section summarizes the findings of the Site's CCR Rule Detection Monitoring (DM) program, the associated Appendix III ASD, and the subsequent AM program and Appendix IV ASD which, taken together, led to the requirement to conduct the ACM. Details on each phase of monitoring and the ASDs can be found in the referenced documents and the pertinent Annual Groundwater Monitoring and Corrective Action Reports.

2.1 DETECTION MONITORING & APPENDIX III ALTERNATE SOURCE DEMONSTRATION

2.1.1 Detection Monitoring Results

FE performed the first DM sampling event in October 2017. Following receipt of the validated analytical results, a statistical evaluation of the data was completed in January 2018 and the results indicated that there were statistically significant increases (SSIs) for boron, calcium, chloride, pH, sulfate and total dissolved solids (TDS) in one or more well comparisons. The DM sampling, analysis, statistical evaluation, and findings were included in the 2017 and 2018 CCR Annual Groundwater Monitoring and Corrective Action Reports which are available on the Site's publicly accessible CCR website (http://ccrdocs.firstenergycorp.com/).

2.1.2 Alternate Source Demonstration

Following the identification of SSIs in downgradient Site well samples for Appendix III parameters identified in Section 2.1.1, FE performed an ASD per 40 CFR § 257.94(e)(2). The ASD was performed by Tetra Tech, Inc. (Tetra Tech) to determine whether a source other than the CCR unit caused the SSIs or that the apparent SSIs resulted from errors in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The ASD scope and findings are presented in the Tetra Tech report entitled, "CCR Appendix III Alternative Source Demonstration Report - 2017 Detection Monitoring, Coal Combustion Byproduct Landfill, Hatfield's Ferry Power Station," dated April 15, 2018. The subject report was placed in the facility's operating record in April 2018. The Appendix III ASD concluded that there are potential on-site sources which may have contributed to the SSIs for some constituents; however, it was not possible within the scope of work conducted to definitively confirm these sources resulted in all the SSIs.

Since the ASD did not conclusively determine that all of the SSI constituents were related to sources or conditions other than the CCR unit, in accordance with 40 CFR 257.95(b), the Station transitioned from Detection Monitoring to Assessment Monitoring (discussed in the following section).

2.2 ASSESSMENT MONITORING & APPENDIX IV ALTERNATE SOURCE DEMONSTRATION

FE performed two rounds of Assessment Monitoring at the Site in June and August 2018 (events AM-1 and AM-2, respectively) in accordance with the facility's CCR groundwater monitoring plan. Following receipt of the validated analytical results, FE performed statistical evaluations of the 2018 AM data to

determine whether there were any detected Appendix IV parameters with SSLs above the CCR unit's established GWPSs. Lithium and cobalt were the only parameters detected at concentrations greater than their respective GWPS, as documented in the facility's Operating Record in February 2019. FE subsequently performed the first of the 2019 AM sampling events (AM-3) in February 2019, and the validated data was statistically evaluated in August 2019. The AM-3 results were consistent with the previous AM results (the lithium and cobalt data from sampling events AM-1, -2, and -3 are provided in the Appendix IV ASD report included as Attachment A of this report). The second 2019 AM sampling event (AM-4) was performed by FE in September 2019, but receipt and statistical evaluation of the validated data was not completed in time to be included with this ACM report. Those findings will be included as part of the CCR unit's 2019 AGWMCA Report. To date, no other Appendix IV constituents have been detected at SSLs above the their GWPS under the facility's AM program.

Pursuant to 40 CFR § 257.95(g)(3)(ii), Tetra Tech performed an ASD to assess if the Appendix IV SSLs for lithium and cobalt determined for events AM-1, -2, and -3 were attributable to a release from the CCR unit or from a demonstrable alternative source(s). As part of the Appendix IV ASD, two nature and extent of release characterization sampling events were performed in June and July 2019 and results from those sampling events were consistent with the AM-1, -2, and -3 results. Based on this and other findings documented in the Appendix IV ASD included as Appendix A, the SSLs for cobalt are attributed to an on-site source (a former maintenance building) other than the CCR unit, but the SSLs for lithium could not be attributed to sources other than the CCR unit. As such, a transition to N&E characterization and ACM for lithium per § 257.96 of the CCR Rule commenced as discussed in the following sections.

3.0 NATURE AND EXTENT OF RELEASE CHARACTERIZATION

Pursuant to 40 CFR 257.95(g)(1), FE initiated an N&E of release characterization concurrently while performing the Appendix IV ASD; following confirmation that the lithium SSL was not attributed to sources other than the CCR unit N&E characterization continued and ACM commenced. This section summarizes the occurrence and fate and migration characteristics of lithium, N&E activities conducted as part of the CCR Rule requirements, temporal changes in lithium concentrations in Site leachate and groundwater as well as the extent of lithium in Site groundwater as identified by the N&E activities. As discussed further below, there were several existing wells associated with monitoring under the state solid waste permit which were screened in the monitored CCR Rule aquifer(s) and located upgradient and downgradient of some of the CCR wells. These existing wells were incorporated into the N&E program and fulfilled the requirement under 40 CFR 257.95(g)(1)(iii) to have at least one additional monitoring well positioned at the facility boundary in the direction of contaminant migration.

3.1 NATURE OF LITHIUM

The following is an overview of lithium occurrence and fate and transport in the environment from the USGS Professional Paper 1802-K, "Lithium – Chapter K of Critical Mineral Resources of the United States – Economic and Environmental Geology and Prospects for Future Supply" 2017.

- In most geologic settings, lithium is found only as a trace element, measured in parts per million (ppm).
- The upper continental crust (that is, rocks typically at Earth's surface on land) contains an average of 20 ppm lithium.
- Lithium is extremely soluble. During weathering of rocks, it tends to be removed in solution and carried to the sea by rivers. Thus, lithium would be expected to have built up in the oceans in the same way that a buildup of sodium has made the oceans salty. Yet, remarkably, seawater

contains less than 1 ppm lithium. The likely explanation is that seawater lithium is scavenged in trace quantities by clay minerals and accumulates in sea-floor oozes.

- Deep oilfield brines may contain up to several hundreds of parts per million lithium. It has been reported that there are high tonnages of lithium contained in oilfield brines in Arkansas, North Dakota, Oklahoma, Texas, and Wyoming, with lithium concentrations of up to 700 ppm.
- Lithium in the environment can be derived from both natural and anthropogenic sources. Potential anthropogenic lithium sources include mine wastes and, after disposal, a wide range of manufactured products.
- Being a highly soluble element, lithium is commonly found as a dissolved species in both groundwater and surface water. This property makes lithium useful as a conservative tracer in hydrogeological studies. There is evidence, however, that lithium may be removed from solution through sorption onto suspended clays.
- Lithium substitutes readily for magnesium in clay structure because of the similar ionic radii of the two elements, and this isomorphic substitution is likely responsible for the affinity of lithium for clays. Plant uptake is another mechanism by which lithium can be removed from solution, especially soil solution. There is a much greater uptake of lithium by plants in acidic soils, as acidity increases the solubility of metals.
- Lithium is not considered an essential element for life, but it is present in most organisms in trace quantities. The normal human intake is about 2 milligrams per day (mg/d), and the human body contains about 7 milligrams (mg).

Research into state and federal National Pollutant Discharge Elimination System (NPDES) standards by Tetra Tech indicates that there are no current USEPA or PADEP NPDES criteria for lithium. Some reference points on toxicity and environmental impacts include the USEPA provisional chronic oral reference dose limit of 0.70 mg/L and the acute environmental effect concentration in toxicity tests of 33 to 197 mg/L. These reference points indicate that lithium has an overall low human and environmental toxicity. It is also noted that lithium is found naturally occurring in water at various concentrations depending on the region.

3.2 NATURE AND EXTENT OF RELEASE CHARACTERIZATION ACTIVITIES

In an effort to characterize the nature and extent of lithium in groundwater at the Site and gather information which could be helpful in evaluating potential corrective measures, the following activities were conducted by Tetra Tech in 2019.

3.2.1 Additional Monitoring Points

As previously noted, there are several monitoring wells and piezometers present at the Site that are part of the PADEP groundwater monitoring system but are not part of the CCR monitoring network (the basis for the CCR monitoring network development is presented in detail in Tetra Tech, 2017). The locations of these wells and piezometers are shown on Figures 1-1, 1-2, and 1-3, and they either monitor stormwater and/or leachate ponds at the Site (these types of ponds are not required to be monitored by the CCR Rule) or they are currently inactive because they're situated upgradient of the current waste boundary but slated for decommissioning during future permitted upgradient expansion of the waste boundary. Referring to Figure 1-1, the additional wells sampled as part of N&E characterization include MW-210A, -210B, -214A, -214B, -217A, -218A, -222A, -223A, -224A, and piezometers PZ-2 and PZ-5. The "A"-series wells and the piezometers are all set in the mine spoil/bedrock aquifer (i.e., the CCR uppermost

aquifer) and they are used to monitor the LSI; the “B”-series wells are all set in the Uniontown Sandstone Aquifer.

Based on groundwater flow patterns at the site and a review of aquifer geochemistry analyses included in the CCBL’s solid waste permit application, it was determined that the “A”-series wells and piezometers surrounding the LSI and “B”-series wells upgradient of the CCBL would be of use, so they were integrated with the existing CCR monitoring network wells to establish the N&E well network used for this ACM.

3.2.2 N&E Sampling and Analysis Program

Two rounds of groundwater sampling were performed for the N&E network described in Section 3.2.1 with samples being analyzed for Appendix III parameters and lithium along with other Appendix IV parameters detected during the AM program. Samples were collected in June and July of 2019 in accordance with the Site’s CCR Groundwater Sampling and Analysis Plan (SAP). Laboratory analysis and data validation activities were completed in August and September 2019 with the findings presented in the following section.

3.3 EXTENT OF LITHIUM AND TRENDS IN CONCENTRATION

Figure 3-1 presents all of the site-wide lithium concentrations that have been measured in both groundwater and leachate since the inception of the CCR monitoring program in January 2017 (as previously noted, there is no historical lithium data for the Site prior to 2017 since lithium was not a parameter that was required in the PADEP solid waste permit monitoring program). The data gap between August 2017 and March 2018 represents the period where the CCR DM program was in effect which only required analysis for Appendix III parameters. Referring to Figure 3-1, it’s seen that the lithium concentrations in the upgradient wells for the Mine spoil/bedrock (MW-212A) and for the Uniontown sandstone (MW-215B) both established Upper Prediction Limits (UPLs) greater than the USEPA Regional Screening Level (RSL) of 0.04 mg/L during the background data collection phase of the CCR program (eight sampling events between January and August 2017). For MW-212A, the UPL is 0.083052 mg/L and for MW-215B the UPL is 0.07311 mg/L. Since these UPLs are greater than the RSL, they represent the established GWPS at the Site.

Once the AM program commenced in early 2018, lithium concentrations for all of the downgradient wells, except for MW-203B, were consistently measured at or above the site-specific UPLs and did not exhibit notable increasing or decreasing trends (i.e., they have been consistent). Most of the N&E sampling data obtained in June and July 2019, which included the additional monitoring points noted in Section 3.2.1, fit within the established concentration ranges and trends. The exceptions included wells MW-217A and -218A, which were both higher than the other downgradient wells at the Site, and within the range of lithium concentrations measured in the CCBL leachate (sampling points LCSC-1, LCSC-2, DP1WD, and DP2WD), and well MW-222A, which showed a sharp decrease in concentration between the two N&E sampling events. The higher lithium concentrations in MW-217A and -218A may be attributable to fly ash that was historically used as surface mine backfill throughout that portion of the Site before development of the landfill’s Phase I and II disposal areas.

Figure 3-2 is an iso-concentration map representative of the distribution of total lithium in groundwater in the Mine Spoil/weathered bedrock aquifer. The lithium concentrations presented are the results of the July 2019 sampling event, which were typically the higher of the two N&E sampling events. Concentrations greater than the current lithium GWPS of 0.083052 for this aquifer are shaded on the maps. As indicated, the highest concentrations of lithium occur in the wells and piezometers surrounding the LSI (east of the CCR unit), ranging from approximately 0.02 (PZ-2) to 0.323 mg/L (MW-218A). The next highest concentrations occur along the northern edge of the CCR unit in wells that encompass both the Mine Spoil/weathered bedrock and Uniontown Sandstone aquifers (MW-202B and -204B) with a

tighter range of between approximately 0.12 and 0.14 mg/L. It's also of note that there's an area on the upgradient (southern) end of the site encompassing wells MW-210A, -214A, and -215A, that exhibits lithium concentrations above the GWPS, ranging from approximately 0.12 to 0.20 mg/L. These results support the possibility that the mine spoil is also contributing to the lithium concentrations being observed at the site, which is discussed in the Appendix IV ASD included as Appendix A. Figure 3-2 also depicts attenuation of the lithium concentration down to the UPL based on interpolation of the measured concentration gradients in several areas along the parcel boundary. Based on these interpretations, lithium concentrations in groundwater that are above the Site's GWPS are located approximately 500 feet upgradient of the FE property line along the northern direction of flow and approximately 1,600 feet upgradient of the FE property line along the eastern direction of flow. In both instances, lithium does not appear to be migrating off-site.

Figure 3-3 is an iso-concentration map representative of the distribution of total lithium in groundwater in the Uniontown Sandstone. As before, the lithium concentrations presented are the results of the July 2019 N&E sampling event. Concentrations greater than the current lithium GWPS of 0.07311 for this aquifer are shaded on the maps. Similar to Figure 3-2, this mapping shows elevated lithium concentrations occurring along the northern edge of the CCR unit in wells that encompass both the Mine Spoil/weathered bedrock and Uniontown Sandstone aquifers (wells MW-202B and -204B, ranging from approximately 0.12 to 0.14 mg/L) and in the upgradient (southern) end of the site, but only encompassing wells MW-214B and -215B (ranging from approximately 0.08 to 0.11 mg/L). Wells MW-212B and MW-213B could not be sampled due to insufficient volumes of water in the wells. As before, these results support the possibility that the mine spoil is also contributing to the lithium concentrations being observed at the site in the Uniontown Sandstone aquifer, which is discussed in the Appendix IV ASD included as Appendix A. Figure 3-3 also depicts attenuation of the lithium levels down to the UPL based on interpolation of the measured concentration gradients. Based on these interpretations, lithium concentrations in groundwater in the Uniontown Sandstone aquifer that are above the Site's GWPS are approximately 500 feet upgradient of the FE property line along the northern direction of flow and more than 5,000 feet upgradient of the FE property line along the eastern direction of flow.

4.0 CONCEPTUAL SITE MODEL

4.1 HYDROGEOLOGIC CHARACTERISTICS

This section provides an overview of hydrogeologic characteristics at the Site based on previous studies as well as more recent work completed under the CCR Rule monitoring program. A more detailed discussion of the site's geologic and hydrogeologic characteristics can be found in the "CCR Groundwater Monitoring System Evaluation Report, Hatfield's Ferry Power Station CCB Landfill", Tetra Tech, October 2017.

Groundwater in the CCBL area occurs primarily within the mine spoil and underlying fractured bedrock and flow is primarily controlled by topography and by the bedrock structure (i.e., dip). The uppermost aquifer in the CCBL area is the mine spoil/weathered bedrock aquifer (shallow aquifer). Recharge to this aquifer is from precipitation infiltration through the relatively permeable mine spoil materials to the underlying bedrock, where the groundwater preferentially migrates laterally through the unconsolidated mine spoil materials and within the underlying upper few feet of highly fractured, weathered bedrock. Some of the shallow groundwater also migrates to underlying aquifers through vertical fractures in the bedrock. Groundwater elevations across the site in the shallow aquifer generally range from 1060 to 1020 feet msl, with lower elevations in the northern and eastern valleys where erosion has exposed the Monongahela Group strata.

Within the footprint of the CCBL, the mine spoil/weathered bedrock and underlying Uniontown Sandstone form a single interconnected flow unit, as the shallow mine spoil/weathered bedrock groundwater discharges/infiltrates directly into the Uniontown Sandstone north of the former outcrop of the Waynesburg Coal near wells MW-202B, -203B, and -204B. The Uniontown Sandstone is directly underlain by a shale layer that serves as an aquitard to prevent further downward vertical groundwater flow into lower aquifers at the site. The mine spoil/weathered bedrock unit has been identified as the uppermost aquifer for CCR Rule groundwater monitoring under most of the CCBL area, with the underlying Uniontown sandstone considered the uppermost aquifer in those CCBL areas located north of the former outcrop of the Waynesburg coal.

Hydrogeologic properties for the CCBL area have been estimated as part of previous studies (referenced in Tetra Tech, October 2017). Estimates of hydraulic conductivity (K) are available for the mine spoil and bedrock and are based on limited testing data and should be considered generalized estimates only. Calculated K values for the mine spoil average 144 feet per day, based on a combination of slug tests and pumping tests performed at the site. Based on slug tests, the bulk hydraulic conductivities within the Uniontown sandstone range from less than 0.01 to 14.4 feet per day, with an overall reported average of approximately 2.4 feet per day.

Historic and recent groundwater level data indicate groundwater flow within the mine spoil/weathered bedrock aquifer is primarily to the north along the slope of the top of bedrock. A portion of the shallow groundwater in the eastern portion of the CCBL (northeast of the waste boundary) also flows eastward (see Figure 1-2). Groundwater in the Uniontown sandstone aquifer migrates primarily to the northeast and east towards outcrop areas along major drainage features in the area (see Figure 1-3). As noted in Section 1.3, leachate and groundwater from the Phase I and II areas are collected by an underdrain system, then routed through passive treatment wetlands before being discharged off-site via a stormwater control pond. It is believed that this underdrain system has a significant impact in reducing groundwater flow and hydraulic heads downgradient of the northern end of the landfill as it captures and reroutes groundwater which would otherwise continue to flow downgradient of the landfill. Approximately 24 gallons per minute (gpm) of flow is extracted from the groundwater system as part of this process, the net effect being a lower hydraulic head and groundwater flow volume beneath the landfill toe in this area than would otherwise occur.

Appendix C provides geologic cross-sections completed as part of the solid waste permit application for the site. Cross-Section J-J' is a generally south-north cross-section extending from the upgradient portion of the landfill area to the edge of the Site property. The section cuts through the central portion of the Phase III Expansion area and depicts the bedrock and mine spoil immediately below the CCBL. As shown, groundwater occurs under unconfined conditions in the line of section where it occurs primarily in the mine spoil/weathered bedrock throughout the area underlying the CCBL and is in hydraulic communication with the underlying Uniontown Sandstone down-valley. Cross-Section L-L' is generally an west-east cross-section extending from the upgradient portion of the landfill area, past the eastern edge of the CCBL, and ending near the middle of the LSI area. As indicated, groundwater in the line of section area occurs under unconfined conditions primarily in the mine spoil/weathered bedrock mimicking the weathered bedrock interface with the mine spoil. In this area of the CCBL, the mine spoil/weathered bedrock and Uniontown Sandstone appear to be less hydraulically connected.

4.2 POTENTIAL RECEPTORS

Based on information contained in Form 2R of the CCBL's state solid waste permit application and on information contained in the Pennsylvania Groundwater Information System (PAGWIS) online database, all groundwater wells in the vicinity of the Site are either positioned upgradient of and/or separated from groundwater impacted by the CCR unit by hydrogeologic barriers or divides, including Little Whitely Creek

to the north of the Site and the Monongahela River east of the Site. As such, the uppermost aquifer at the Site has been designated as a "non-use" aquifer for state solid waste permit compliance purposes. The nearest downgradient drinking water well located off FE property is on the opposite side of the Monongahela River, which acts as a hydrogeologic barrier, several thousand feet east-northeast of the CCR unit boundary, as shown on Figure 4-1. As discussed further below, it is believed that the portion of groundwater in the upper aquifer which flows to the north discharges to Little Whitely Creek, while the portion of groundwater that flows to the east discharges to the Monongahela River. However, given the measured and interpolated lithium concentrations shown on Figures 3-2 and 3-3, the lithium levels discharged from groundwater are considered to be below any levels of potential concern to aquatic life (discussed in more detail in Section 6.5.4).

4.3 SUMMARY OF CSM

Figures 4-2 and 4-3 are generalized cross-sections presenting the Site CSM. In summary, the CSM consists of lithium leaching from mine spoil and CCRs at the Site and entering Site groundwater at the base of the CCBL. As depicted on Figure 4-2, a relatively large volume of leachate and groundwater flowing to the north is removed from the groundwater system by the Phase I and II underdrain and routed through treatment wetlands before being discharged off-site via a stormwater control pond. As depicted on Figure 4-3, impacted groundwater flowing to the northeast and east discharges to the ground surface via seeps in the valley positioned below the LSI where it undergoes attenuation based on natural dilution with surface water flows entering the area from the north and south before ultimately discharging to the Monongahela River. As previously noted, the nearest downgradient drinking water well is located on the opposite side of the Monongahela River, several thousand feet from the CCR waste boundary.

5.0 IDENTIFICATION AND SCREENING OF REMEDIATION TECHNOLOGIES

This section identifies the remediation technologies which were evaluated as part of this ACM and summarizes the technology including associated advantages and disadvantages. The technologies include those pertaining to source control and those addressing the impacted groundwater downgradient of the CCBL.

5.1 SOURCE CONTROL

When remediating impacted groundwater, controlling on-site sources of historical, current, and future contamination to the aquifer are key components to the overall remediation plan. Source control includes a range of potential actions such as treatment in-place, removal, or containment, or some combination of these actions with the goal of reducing or eliminating, to the extent practicable, future releases.

5.1.1 Treatment in Place

For a dry disposal landfill like the existing CCR unit, options for in place source treatment would include amending the landfilled CCRs to reduce their permeability in order to minimize surface water and groundwater infiltration and associated leachate development, or to chemically fixate the contaminants of concern and prevent them from leaching out. Amendment of the in-place CCRs would be accomplished by either localized excavation followed by blending with an appropriate amending agent (e.g., natural clays or lime) and then replacement, or by the use of drilled high-pressure injection wells to introduce an amending agent slurry (e.g., Portland cement). However, given both the surface area and volume of materials present in a large landfill like the CCR unit, implementation of such treatment in-place technologies is impractical and has only been noted herein for completeness in presenting options.

5.1.2 Removal

Source removal for a dry disposal landfill can include both solid matrix (the CCRs themselves) and liquid matrix (the leachate generated due to infiltration of precipitation, surface water, and groundwater into and through the landfilled CCRs). Solid matrix removal would include excavating, loading and hauling all of the CCRs currently located in unlined disposal areas and placing them in existing or new on-site or off-site lined disposal areas. Liquid matrix removal would include collecting and conveying CCR leachate generated in unlined areas to appropriate holding/equalization facilities before discharging it for either treatment or transport and disposal (e.g., in deep underground injection wells).

In general, advantages include:

- Oftentimes reduces the timeframe over which remediation goals can be attained; and
- Effectively eliminates the potential for future contamination to occur.

In general, disadvantages include:

- For solid matrix removal, an increased overall risk to cleanup workers, the surrounding community, and the environment due to factors such as fugitive dust generation and heavy construction equipment emissions;
- If off-site transport and disposal is required, an increased potential for severe cross-media environmental effects and safety hazards due to accidents; and
- For a large volume site, removal activities could take an unreasonable amount of time to complete and be financially infeasible.

Given the volume of materials present in a large landfill like the CCR unit and the corresponding effects that the disadvantages noted above would entail for a facility of such size, implementation of solid matrix removal is impractical and noted herein for completeness in presenting options. However, as noted in Section 1.3 of this Report, liquid matrix (leachate) removal is a viable option due to the presence of the underdrain systems in the unlined Phase I and II disposal areas at the Site and the associated treatment wetlands system, which is already in place and operating.

5.1.3 Containment

Source containment approaches for a dry disposal landfill would include the construction of a final cover (capping) system and/or the installation of a subsurface cutoff wall. Construction of a final cover system atop all exposed CCR surfaces would eliminate source material releases due to stormwater erosion or fugitive dust generation and would reduce leachate generation by minimizing the infiltration of storm water into the underlying CCRs. Installation of a low permeability upgradient groundwater cutoff wall by trench excavation and/or drilled high pressure injection grouting would minimize source contaminant mobilization by preventing groundwater flow into or through the landfilled CCRs.

In general, advantages include:

- Implementation can usually be completed in a relatively short period of time;
- Final cover system design and construction have well-established processes with a proven performance history;
- Oftentimes reduces the timeframe over which remediation goals can be attained; and
- Effectively minimizes the potential for future contamination to occur.

In general, disadvantages include:

- For cutoff walls, subsurface conditions must be favorable across the Site in order to construct an effective and reliable groundwater flow barrier (this is particularly difficult for controlling fractured bedrock flow);
- Depending on the landfill geometry, final cover systems can be difficult to design with respect to maintaining long-term slope stability and reliable stormwater collection and conveyance controls; and
- Final cover systems require routine monitoring, maintenance, and repair throughout their service life.

Given both the large size and the geologic and hydrogeologic characteristics of the Site, the installation of an effective groundwater cutoff wall is impractical and is noted herein for completeness in presenting options. However, construction of a final cover system (either a soil-only or typical regulatory composite cap) is a viable option for the CCR unit and is required under the solid waste permit issued by PADEP for the Site.

5.2 GROUNDWATER EXTRACTION AND TREATMENT

Groundwater extraction and treatment (also referred to as “pump and treat”) can be used as a containment strategy at or near the source of contamination or to reduce or eliminate the downgradient migration of a plume. The technology accomplishes a certain amount of mass removal from the plume. In its simplest form, extraction and treatment involves the installation and pumping of vertical extraction wells with the extracted water treated for the contaminant(s) of concern using methods appropriate for the type of contaminant (e.g., air stripping for volatile organic compounds, chemical precipitation for certain inorganic compounds, etc.). As with most remedial technologies it is most effective following source control. In most cases the groundwater treatment results in a need to manage residuals (e.g., sludges, filters, etc.) which may also act as a source of contamination if not properly managed. Extraction and treatment system application often has associated contaminant “rebound” effects related to desorption of additional contaminant mass from aquifer materials following the initial extraction phase. Groundwater extraction and treatment can also be accomplished via horizontal wells.

In general, advantages include:

- Accomplishes some contaminant mass removal; and
- Can help to protect receptors (e.g., drinking water wells) by preventing migration beyond the extraction wells.

In general, disadvantages include:

- Likely to have limited success under heterogenous or low permeability aquifer conditions;
- Often requires long term operation and maintenance and power usage;
- Results in treatment residuals which must subsequently be managed; and
- “Rebound” effects can inhibit the ability to achieve remedial goals.

5.3 IN-SITU TECHNOLOGIES

As opposed to technologies such as groundwater extraction and treatment which involve mechanical systems that must be continually operated, “passive” in-situ technologies operate primarily by using a site’s natural characteristics (e.g., groundwater flow direction, aquifer geochemical conditions, etc.) to achieve remedial goals. As discussed in this section, in-situ technologies require a strong understanding of an impacted aquifer’s physical and geochemical characteristics, which can be “built upon” to achieve

remedial goals through adding appropriate reagents to the subsurface environment to achieve contaminant reduction through processes such as adsorption, precipitation, etc.

5.3.1 Permeable Reactive Barriers (PRBs):

A permeable reactive barrier (PRB) typically involves digging a trench perpendicular to groundwater flow and of sufficient depth to intercept a groundwater plume, then placing a reagent in the trench which will react with the impacted groundwater flowing through it in order to reduce contaminant concentrations, primarily through adsorption or precipitation. The reagent is selected based on the constituent of concern and geochemical conditions of the aquifer (e.g. pH and redox conditions). Certain contaminants are much more amenable to PRB treatment based on their physical and chemical properties. A commonly used reagent is Zero Valent Iron (ZVI) which can be used to convert certain contaminants to non-toxic or immobile species. ZVI has been shown to be effective in treating many halogenated hydrocarbons as well as removing hexavalent chromium, arsenic, and uranium (“Permeable Reactive Barriers, Permeable Treatment Zones and Application of Zero-Valent Iron”, USEPA Clu-In Technologies website.) A funnel and gate type approach can also be utilized for PRBs where low permeability walls (the funnel) direct groundwater toward a permeable zone containing the reagent (the gate). Some gates are constructed to be readily accessible to facilitate the replacement of the reagent.

In general, advantages include:

- Essentially a passive type approach (i.e., no continuous operational oversight needed, maintenance is infrequent, etc.); and
- Can be very effective for certain types of contaminants and under the necessary hydrogeologic conditions.

In general, disadvantages include:

- Not suitable for bedrock aquifers;
- Limited by viable trenching depth;
- Suitable reagents have not been proven for all contaminant types (e.g., lithium); and
- Reactive agent(s) must be replaced on a scheduled basis.

Application of PRB technology at the Site is not considered viable since the uppermost aquifer system includes a fractured bedrock flow component. In addition, Tetra Tech is not aware of any current application of PRB technology to remediate lithium in groundwater. As such, it will not be considered in the evaluation of corrective measures discussion in Section 6.0.

5.3.2 In-Situ Chemical Stabilization via Injection Wells

In-situ chemical stabilization involves injection into the subsurface via drilled wells a reagent that will result in the precipitation or adsorption of the constituent of concern, and thereby reduce its concentration in groundwater within and downgradient of the injection area. The type of reagent used will depend on the constituent and geochemical conditions within the aquifer including pH, redox conditions, types of natural clays which may be present, etc. It is critical that the aquifer characteristics, particularly permeability, lend themselves to suitable mixing of the reagent with impacted groundwater. Bench scale testing is typically performed to evaluate viability and, if found to be viable, to support design.

In general, advantages include:

- An overall passive approach with minimal disruption of the Site.

In general, disadvantages include:

- Proven reagents are not available for all CCR constituents (e.g., lithium);
- Changes in geochemistry or aquifer conditions outside of the injection interval may cause certain reactions to "reverse";
- It can be difficult to achieve the desired mixing of the reagent with impacted groundwater under low permeability and/or heterogenous aquifer conditions (e.g., fractured bedrock); and
- The longevity of the reagents can be difficult to forecast.

5.4 MONITORED NATURAL ATTENUATION (MNA)

The following summary of MNA is based on USEPA Directive 9200.4 – 17P "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites", April 21, 1999.

> The term 'monitored natural attenuation'… refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants

The USEPA directive lists the following among the advantages and disadvantages of the MNA approach:

Potential advantages of MNA include:

- As with any in situ process, generation of lesser volume of remediation wastes, reduced potential for cross-media transfer of contaminants commonly associated with ex situ treatment, and reduced risk of human exposure to contaminants, contaminated media, and other hazards, and reduced disturbances to ecological receptors;
- Less intrusion as few surface structures are required;
- Potential for application to all or part of a given site, depending on site conditions and remediation objectives;
- Use in conjunction with, or as a follow-up to, other (active) remedial measures; and
- Potentially lower overall remediation costs than those associated with active remediation.

The potential disadvantages of MNA include:

- Longer time frames may be required to achieve remediation objectives, compared to active remediation measures at a given site;
- Site characterization can often be more complex and costly;
- Long-term performance monitoring will generally be more extensive and for a longer time;
- Institutional controls may be necessary to ensure long term protectiveness;
- Potential exists for continued contamination migration, and/or cross-media transfer of contaminants; and

- Hydrologic and geochemical conditions amenable to natural attenuation may change over time and could result in renewed mobility of previously stabilized contaminants (or naturally occurring metals), adversely impacting remedial effectiveness.

In addition to the above USEPA Directive, a companion Directive was also issued: "Use Of Monitored Natural Attenuation For Inorganic Contaminants In Groundwater At Superfund Sites", August 2015, USEPA. Although the Directive does not specifically address lithium, it discusses a methodology for considering MNA as a remedial strategy for several inorganic constituents and expands upon the Tiered Analysis Approach for Developing Multiple Lines of Evidence presented in the original 1999 Directive.

6.0 ASSESSMENT OF CORRECTIVE MEASURES

6.1 OBJECTIVE

The objective of this Assessment of Corrective Measures section is to provide a high-level evaluation of each of the viable remediation technologies presented in Section 5.0 with regard to the criteria identified in 40 CFR § 257.96(c) and previously presented in Section 1.2 of this report. These evaluations are summarized below and in Table 6-1. The criteria evaluated in Sections 6.2 through 6.5 are performance-related, so each of the technologies has been assigned a subjective rating of "Low", "Medium", or "High" based on how they are anticipated to satisfy each criterion. For the criteria evaluated in Sections 6.6 (time to begin and complete remedy) and 6.7 (institutional requirements), subjective ratings of "Short", "Medium", or "Long" and "Minimal", "Moderate", and "Extensive" have been assigned, respectively. As discussed in Section 5.3.1, the PRB technology was not considered viable due to the primary aquifer type being fractured bedrock; therefore, it is not included in the evaluations below. A more detailed evaluation of technologies leading to a final selection of remedy will be performed and reported as discussed in Section 7 of this report.

6.2 PERFORMANCE

This section discusses the anticipated performance of each technology relative to its ability to achieve remedial goals in consideration of the CSM. Technologies are ranked as "Low", "Medium", or "High" with regard to their effectiveness in reducing lithium concentrations in groundwater.

6.2.1 Source Control

Removal of Leachate - High

As discussed in Sections 1.3 and 5.1.2, the entire footprint of the unlined Phase I and II portions of the landfill is underlain by an underdrain system. The system collects and conveys leachate and groundwater to the passive treatment wetlands located adjacent to the northern landfill toe, with the post-treatment effluent then discharged off-site via a stormwater control pond. Taken together, the underdrain and treatment wetland systems remove large volumes of impacted source water from the local groundwater recharge zone, which reduces both the groundwater flow rates and the total contaminant loading on the monitored aquifer.

Containment using Final Cover System – Medium to High

As discussed in Section 5.1.3, constructing a final cover system atop all exposed CCR surfaces would minimize the infiltration of storm water into the underlying CCRs which would, in turn, reduce both the groundwater flow rates and the total contaminant loading on the monitored aquifer(s). The magnitude and extent of these reductions depend on the type of final cover system(s) utilized at the Site. As per the

CCR unit's current Closure Plan (available on the Site's publicly accessible CCR website - http://ccrdocs.firstenergycorp.com/), the existing unlined Phase I and II disposal areas currently use a soil-only cover system. However, the Phase I and II areas as well as the lined Phase III area will ultimately have a composite cover system installed that includes a geomembrane cap component once final closure of the entire landfill facility is initiated. The soil-only cover system provides a medium level of containment performance while the composite cover system would provide a high level of containment performance. With these factors in mind, it's possible that the existing soil-only cover system may remain in place for several years, which would include much of the remediation activity period.

6.2.2 Groundwater Extraction and Treatment

Low. It is anticipated that the performance of a groundwater extraction and treatment system would be poor due to the anisotropic nature (i.e., mine spoil and fractured bedrock) and overall high permeability of the aquifer. As discussed above, a significant volume of leachate and groundwater are already being removed by the Phase I and II underdrain systems. It is noted that even though the cross-sectional areas through the northern and east/northeastern flow paths are relatively narrow downgradient of the landfill, it is likely many extraction wells would be necessary to ensure that all groundwater flow paths were being captured considering the fractured flow components in the aquifer system.

6.2.3 In-Situ Technologies

Chemical Stabilization via Injection Wells – Low to Medium

In general, lithium stabilization via reagent interaction would likely be challenging due to lithium's high mobility. In addition, the anisotropic nature and relatively high permeability of the mine spoil/bedrock aquifer would make in-situ treatment by injection wells difficult from the standpoint of achieving adequate contact and reagent mixing with the impacted groundwater.

6.2.4 Monitored Natural Attenuation (MNA)

High. As discussed in Sections 3.2 and 4.2, it's believed that attenuation of the lithium levels down to the UPL-based GWPS is occurring based on interpolation of the measured concentration gradients. In addition, the uppermost aquifer at the Site is considered a non-use aquifer with respect to downgradient drinking water wells, and the lithium levels discharged from groundwater are considered to be below any levels of potential concern to aquatic life. Taken together, the anticipated ongoing performance of MNA would be high, provided it is combined with the continued operation of the Phase I/II underdrain and treatment wetland systems and the eventual installation of the permitted composite cover system.

6.3 RELIABILITY

Reliability is the anticipated consistency of a technology to function as designed/expected under variable site-specific conditions. Factors which affect reliability can include aquifer variability (e.g., groundwater geochemistry and flow changes) and equipment performance (e.g., power outages and frequency of maintenance activities). Technologies are ranked as "Low", "Medium", or "High" with regard to their effectiveness in consistently reducing lithium concentrations in groundwater.

6.3.1 Source Control

Removal of Leachate - High

The Phase I/II underdrain has been in place and functioning reliably since CCR disposal operations commenced at the Site. Similarly, the treatment wetland system has been reliably functioning since it was constructed and brought on-line approximately 15 years ago. Both systems are expected to continue

to be highly reliable as long as they are properly monitored, operated, and maintained, which FE will do for the remainder of the landfill's operating life and for the duration of the landfill's post-closure period as required by the state Solid Waste Permit.

Containment Using Final Cover System - High

The existing soil-only cover system has been utilized and has functioned reliably on all the disposal areas that have been developed at the Site since operations commenced. The composite cover system that is proposed for use during final closure has been designed and will be constructed in accordance with well-established practices and incorporates an upper layer of vegetated cover soil that's comparable to the soil-only cover system. Both systems are expected to continue to be highly reliable as long as they are properly monitored and maintained, which FE will do for the remainder of the landfill's operating life and for the duration of the landfill's post-closure period as required by the state Solid Waste Permit.

6.3.2 Groundwater Extraction and Treatment

Medium to High. Extraction and treatment would require proper operation and maintenance (O&M) of extraction well equipment (e.g., pumps) and treatment system in order to maintain reliability. Since the uppermost aquifer is comprised mostly of mine spoil, the likely presence of relatively high iron concentrations in the groundwater would require measures to be taken to prevent fouling and deterioration of pumps and treatment equipment as well as any connecting piping.

6.3.3 In-Situ Technologies

Chemical Stabilization via Injection Wells – Low to Medium

It is anticipated that since chemical stabilization of lithium in an aquifer system does not seem to be proven, that reliability would be questionable. Beyond concept reliability, the injection system itself would require proper O&M of the well equipment (e.g., pumps) and the surface batching and feed systems in order to maintain operational reliability.

6.3.4 Monitored Natural Attenuation

High. Based on the factors previously discussed in Section 6.2.4, it is anticipated that reductions in lithium concentrations would be reliable going forward provided it is combined with the continued operation of the Phase I/II underdrain and treatment wetland systems and the eventual installation of the permitted composite cover system.

6.4 EASE OF IMPLEMENTATION

Ease of implementation relates to how challenging the technology installation will be considering site-specific conditions (e.g., degree of aquifer heterogeneity), the complexity of the design effort (e.g., modeling, bench scale and pilot testing, etc.), and the availability of suitable equipment. Technologies are ranked as "Low", "Medium", or "High" with regard to their ease in being installed to begin reducing lithium concentrations in groundwater.

6.4.1 Source Control

Removal of Leachate - High

Both the Phase I/II underdrain and the treatment wetland systems are in-place and have active monitoring, operation, and maintenance programs in effect.

Containment using Final Cover System – Medium to High

The existing soil-only cover system is in-place on all inactive areas of the landfill and an active monitoring and maintenance program is in effect. As such, its ease of installation is high. The proposed composite cover system would require the development of construction-level drawings and specifications and then have to proceed through the Station's procurement process before construction could commence. Construction would entail the use of commonly accepted materials, means, and methods, but ease of completion would depend primarily on the size of the area(s) being covered and seasonal weather constraints. Because of these factors, ease of installation for the composite cover system is considered medium to high.

6.4.2 Groundwater Extraction and Treatment

Medium to Low. It is likely that several groundwater extraction wells would be needed to attempt to capture impacted groundwater. Given the number of above and below ground structures and features in the targeted northern intercept area (e.g., the Phase I and II underdrain concrete sumps and pressurized underdrain conveyance piping, the treatment wetland cells and associated discharge piping, the northern stormwater control pond, access roads, and stormwater controls) and the interferences they would present, siting the wells in the desired locations may prove difficult. Bench scale testing would also need to be conducted to identify the best reagent(s) for use in removing the lithium from solution. Such a bench scale testing program would be expected to go through multiple iterations before establishing the treatment program needs. Because of these factors, ease of installation for this system is considered medium to low.

6.4.3 In-Situ Technologies

Chemical Stabilization via Injection Wells – Low

Implementation would likely be very challenging due to identifying the appropriate reagent(s) and "dosing" strategy to effectively and efficiently treat the aquifer due to the anisotropic conditions. It is likely that various phases of bench scale and field pilot testing would be necessary to support the design.

6.4.4 Monitored Natural Attenuation

High. No additional equipment would be necessary for a natural attenuation remedy. There would possibly be a need to add a limited number of properly constructed monitoring wells in the downgradient area east of the LSI to evaluate the program's performance, but this would not present significant difficulties.

6.5 POTENTIAL IMPACTS OF APPROPRIATE REMEDIES (SAFETY, CROSS-MEDIA AND CONTROL OF EXPOSURE)

Potential impacts of technologies were evaluated considering the following:

- Safety: The likelihood that illness, injury, or death directly related to the technology would occur during construction or operations. In general, "active" technologies and those requiring significant construction effort were considered higher risk than "passive" technologies and those not requiring significant construction effort.
- Cross-Media: The likelihood that the technology will result in a transfer of contaminants to the air, surface water, or soil, either from a direct discharge or from management of treatment residuals.
- Control of Exposure: The likelihood that that the technology will result in exposure of contaminants to human or environmental receptors either from a direct discharge or from management of treatment residuals.

Technologies are ranked as “Low”, “Medium”, or “High” with regard to how likely they are to have negative effects for Safety and Cross-Media, and with regard to how well they avoid negative effects for Control of Exposure.

6.5.1 Source Control

Removal of Leachate

Safety Impacts: **Low to Medium**. The Phase I/II underdrains and the treatment wetland systems are already in-place and have active monitoring, operation, and maintenance programs in effect. These programs mitigate and manage the risks associated with these systems (e.g., exposure to treatment chemicals, mechanical or electrical failures, etc.).

Cross-Media Impacts: **Medium**. The Phase I/II underdrain flows are collected and pumped to the treatment wetlands system via pressurized pipes which have the potential to leak into the surrounding subsurface. Similarly, the treatment wetlands system includes below-grade treatment cells and post-treatment gravity discharge piping which have the potential to leak into the surrounding subsurface or to surface water. In addition, wetland substrate is routinely (but infrequently) removed and replaced and has the potential to impact the ground surface or surface water due to spills that could occur during excavation or transport for disposal. FE utilizes processes during substrate cleanout to minimize the potential for cross-media impacts.

Control of Exposure: **Medium to High**. The Phase I/II underdrain and treatment wetland system flows are conveyed in a combination of unpressurized and pressurized piping and concrete sumps and treatment cells, thus limiting direct exposure. The concrete sumps and treatment cells are open, above-ground structures that do present a medium risk of exposure, both to treated water and also to substrate material during cleanout operations. As mentioned above, FE utilizes processes to minimize exposure during substrate cleanout operations.

Containment using Final Cover System

Safety Impacts: **Low to Medium**. The existing soil-only cover system is in-place and presents little to no implementation-related safety impacts. Construction of the proposed composite cover system would involve typical construction risks, both on-site and off-site, due primarily to material deliveries and heavy equipment operations. However, after construction is completed, the composite cover system would present little to no implementation-related safety impacts.

Cross-Media Impacts: **Low**. Construction of either a soil-only or a composite final cover system atop all exposed CCR surfaces would eliminate source material releases and potential cross-media impacts to the air, ground surface, or surface water due to stormwater erosion or fugitive dust generation.

Control of Exposure: **High**. Construction of either a soil-only or a composite final cover system atop all exposed CCR surfaces would eliminate direct and indirect exposure to the landfilled CCRs.

6.5.2 Groundwater Extraction and Treatment

Safety Impacts: **Medium**. Safety risks associated with drilling extraction wells and construction of the treatment facility would exist but could be minimized through implementation of an appropriate health and safety plan. Likewise, some safety risks would be associated with the operation of the treatment system; however, such risks could be minimized through proper O&M procedures and through implementation of an appropriate health and safety plan.

Cross-Media Impacts: **Medium**. Treatment residuals would need to be managed. In addition, the potential exists for releases from well connections, valves, system piping, and tanks that could impact site soils and potentially groundwater and surface water.

Control of Exposure: **Medium**. Treatment residuals would need to be properly managed to minimize exposure. In addition, the potential exists for exposure to workers and other on-site personnel from any releases which may occur at the well heads, piping, and any storage tanks that are part of the extraction and treatment system.

6.5.3 In-Situ Technologies

Chemical Stabilization via Injection Wells

Safety Impacts: **Medium** – There would be safety risks associated with drilling injection wells and handling reagent.

Cross-Media Impacts: **Low to Medium** – Would need to confirm that selected reagent would not have negative impacts associated with downgradient groundwater discharge to surface water.

Control of Exposure: **Medium to High** – Will require proper handling procedures for the selected reagent.

6.5.4 Monitored Natural Attenuation

Safety Impacts: **Medium** - Some additional construction or well installation would be necessary under the MNA remedy; there would be safety risks associated with possibly installing a limited number of properly constructed monitoring wells in the downgradient area east of the LSI to evaluate the program's performance, but this would not present significant safety impacts.

Cross-Media Impacts: **Low to Medium** – As noted in Section 4.3, the Site CSM indicates groundwater from the monitored aquifer discharges to the north to Little Whitely Creek and to the east to the Monongahela River. However, it's believed that attenuation of the lithium levels down to the UPL-based GWPS is occurring based on interpolation of the measured concentration gradients. Research into state and federal NPDES standards by Tetra Tech indicates that there are no current USEPA or PADEP NPDES criteria for lithium. Some reference points on toxicity and environmental impacts include the USEPA provisional chronic oral reference dose limit of 0.70 mg/L and the acute environmental effect concentration in toxicity tests of 33 to 197 mg/L. These reference points indicate that lithium has an overall low human and environmental toxicity. It is also noted that lithium is found naturally occurring in water at various concentrations depending on the region.

Control of Exposure: **High** - No contamination residuals will be generated. As stated in Section 4.2, the uppermost aquifer at the Site is considered a non-use aquifer with respect to downgradient drinking water wells, and the closest downgradient drinking water user is located on the opposite side of the Monongahela River.

6.6 TIME REQUIRED TO BEGIN AND COMPLETE REMEDY

The anticipated time required to begin and compete a remedy considers factors such as the complexity of the design, construction, and permitting efforts, as well as forecasting how efficient the technology is expected to be in achieving remedial goals in a timely manner. Technologies are ranked as "Short", "Medium", or "Long" with regard to their anticipated time to reduce lithium concentrations in groundwater.

6.6.1 Source Control

Removal of Leachate

Time to Begin Remedy: **Short**. The Phase I/II underdrain and treatment wetland systems are both currently operational.

Time to Complete Remedy: **Short**. Currently working and on-going operation of both systems is considered beneficial in combination with an MNA remedy.

Containment using Final Cover System

Time to Begin Remedy: **Short.** For the existing soil-only cover system, no lead time is required (short). For the composite final cover system, it is anticipated that preparation of construction drawings and documents and contractor procurement would take approximately one year (short).

Time to Complete Remedy: **Short to Medium.** For the existing soil-only cover system, no implementation time is required (short). For the composite cover system, installation would need to be performed using a phased construction approach that would include seasonal (winter) shutdowns, with the total time to complete construction being approximately three years.

6.6.2 Groundwater Extraction and Treatment

Time to Begin Remedy: **Medium.** It is anticipated that one to two years would be required to initiate a groundwater extraction and treatment remedy in order to allow time for modeling to select well locations; to complete well, pipeline and treatment system design and permitting, and to construct the extraction and treatment systems (medium).

Time to Complete Remedy: **Currently Unknown**. Extraction and treatment, while effective at containment in some settings, is often not successful in achieving remedial goals due to "rebound" effects and other field variables that become more defined during system startup and operation.

6.6.3 In-Situ Technologies

Chemical Stabilization via Injection Wells

Time to Begin Remedy: **Medium.** Two to three years are estimated for bench scale testing in order to select the treatment reagent(s), perform modeling to identify injection well locations, complete well and injection system design and permitting, and to install the injection wells and construct the injection system (medium).

Time to Complete Remedy: **Currently Unknown**. The time required to complete the remedy will depend on the duration of leaching of lithium into the aquifer, which is expected to decrease as the CCR unit is covered/capped. The duration of treatment required is difficult to estimate until at least bench scale testing is performed on the selected reagent.

6.6.4 Monitored Natural Attenuation

Time to Begin Remedy: **Short**. As previously noted, it's believed that attenuation of the lithium levels down to the UPL-based GWPS is occurring based on interpolation of the measured concentration gradients.

Time to Complete Remedy: **Long**. Additional monitoring and possibly the installation of additional monitoring well locations would be necessary to confirm that the GWPS is not being exceeded at the facility boundary on a seasonal basis. Ongoing monitoring to confirm the remedy continues to be effective would also be proposed with the duration to be determined as part of the Selection of Remedy process discussed in Section 7.0 of this report (long).

6.7 INSTITUTIONAL REQUIREMENTS (STATE AND LOCAL PERMITS AND OTHER APPROVALS)

Institutional requirements pertain to the anticipated state and local permits and other approvals needed to construct and operate the remedial technology. These can include programs already in-place for a given CCR unit (e.g., solid waste permit) that will need to be modified to accommodate a potential technology, or new programs that may result from a potential technology (e.g., NPDES permit). FE will continue to provide CCR Rule program notifications to PADEP as required by 40 CFR § 257.106 and will also consult with PADEP to confirm anticipated permitting requirements that would be associated with the selected remedy. As mentioned in Section 1.3, the CCBL is permitted under the PADEP residual waste regulations; therefore, consultation with the agency will be required to support remedy selection, design, and implementation. The following summarizes the expected permits/approvals which may be required by PADEP or local authorities for each technology and associated rankings of “Minimal”, “Moderate”, and “Extensive” with regard to the anticipated level of effort that will be needed to obtain them.

6.7.1 Source Control

Removal of Leachate - Minimal

The existing Phase I/II underdrain and treatment wetland systems are regulated under a combination of state-issued Solid Waste and NPDES permits. The continued use of these systems in their current operating capacity would only require the regular renewal of these permits.

Containment using Final Cover System – Minimal to Moderate

Both the existing soil-only cover system and the composite final cover system are regulated under the state-issued Solid Waste Permit. The use of these systems in either their current operating capacity (soil-only cover) or in accordance with their existing design (composite cover) would only require the regular renewal of the Solid Waste permit. Should any modifications to these systems become necessary (e.g., to use newly available geosynthetic materials in the composite cover system) a modification to the Solid Waste permit would be required.

6.7.2 Groundwater Extraction and Treatment

It is anticipated that both an amendment to the landfill’s Solid Waste Permit and a modification to the Site’s NPDES permit will be required for construction and operation of the treatment system. This would likely constitute a moderate to extensive effort. Well locations, piping, and any excavation related to the treatment system would also need to undergo utility clearances.

6.7.3 In-Situ Technologies

Chemical Stabilization via Injection Wells - Moderate

It is anticipated that only an amendment to the landfill’s Solid Waste Permit would be required for construction and operation of an injection system.

6.7.4 Monitored Natural Attenuation

No new or amended permits and/or approvals are anticipated from state or local agencies and authorities for an MNA remedy. The implementation of an MNA remedy would only require the regular renewal of the Solid Waste Permit, which would likely constitute a minimal effort.

6.8 COMPARATIVE ANALYSIS OF CORRECTIVE MEASURES ALTERNATIVES

Based on the evaluation of viable remediation technologies presented in Sections 6.1 through 6.7, MNA, combined with source control by continued operation of the Phase I/II underdrain and treatment wetland systems and the eventual installation of the permitted composite cover system, ranks highest among the evaluated options. It ranks high in performance, reliability, ease of implementation, potential safety impacts and potential for residual contamination impacts. Also, additional monitoring of the N&E network should be conducted to confirm that there are not seasonal changes that could impact effectiveness. These and other additional data needs that are part of the final Selection of Remedy at the Site are discussed in Section 7.2. It is also noted that it is anticipated that the composite final cover system should accelerate the effectiveness of whichever associated corrective measure is selected.

7.0 PROCESS FOR SELECTION OF REMEDY

7.1 SELECTION CRITERIA AND SCHEDULE

As required by 40 CFR § 257.97(a), the Station will, as soon as feasible after completion of this 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). As required by 40 CFR § 257.97(d), the Station will 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),

7.2 ADDITIONAL DATA NEEDS

In order to select a remedy that is both effective and implementable, additional data collection and analyses will be required as summarized below:

- An additional two rounds of quarterly groundwater sampling of the N&E well network (discussed in Section 3.2.1) to confirm that there are no significant seasonal variations in lithium levels which should be taken into account during remedy selection.
- The possible addition of new N&E/MNA monitoring points in the valley downgradient of the LSI.
- Modeling of the monitored aquifer to further evaluate the MNA alternative to assist in forecasting likely long-term effectiveness and to estimate timeframes for completing remedial activities.
- Researching potential reagents for chemical stabilization of lithium via injection wells as presented in Section 5.3.2.

7.3 REMEDY SELECTION PROGRESS REPORTING

As required by 40 CFR § 257.97(a), FE will prepare a semi-annual report describing the progress in selecting and designing the remedy. One of the semi-annual reports will be included in the forthcoming 2019 Annual Groundwater Monitoring and Corrective Action Report, which will be completed in January 2020.

7.4 PUBLIC MEETING

As required by 40 CFR § 257.96(e), FE will discuss the results of the corrective measures assessment at least 30 days prior to the selection of remedy, in a public meeting with interested and affected parties.

7.5 FINAL REMEDY SELECTION

Upon selection of a remedy, FE will prepare a final report describing the selected remedy and how it meets the standards outlined in Section 7.1. The final report will include a certification from a qualified professional engineer that the remedy selected meets the requirements of the selection criteria and the final report will be placed in the Station's operating record as required by § 257.105(h)(12).

8.0 REFERENCES

Tetra Tech, 2017. CCR Groundwater Monitoring System Evaluation Report for the CCB Landfill, Hatfield's Ferry Power Station. October 2017.

Tetra Tech, 2018. 2017 Annual Groundwater Monitoring and Corrective Action Report, Hatfield's Ferry Power Station. January 2018.

Tetra Tech, 2019. 2018 Annual Groundwater Monitoring and Corrective Action Report, Hatfield's Ferry Power Station. January 2019.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. April 21, 1999.

USEPA, 2015. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register Vol. 80, No. 74, Part II 40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System. April 17, 2015.

USEPA, 2015. Use Of Monitored Natural Attenuation For Inorganic Contaminants In Groundwater At Superfund Sites. August 2015.

USGS, 2017. Professional Paper 1802-K, Lithium – Chapter K of Critical Mineral Resources of the United States – Economic and Environmental Geology and Prospects for Future Supply. 2017.

TABLES

Table 6-1. Screening of Potential Corrective Measures Summary
CCR Rule ACM Report
FirstEnergy - Hatfield

	Potential Corrective Measures				
	Source Control		Groundwater Extraction and Treatment	In-Situ Chemical Stabilization via Injeciton Wells	Monitored Natural Attenuation
Evaluation Criteria [per 257.96(c)]	Removal of Leachate	Containment Using Final Cover System			
Performance[1] [257.96(c)(1)]	High	Medium to High	Low	Low to Medium	High
Reliability[1] [257.96(c)(1)]	High	High	Medium to High	Low to Medium	High
Ease of Implementation[1] [257.96(c)(1)]	High	Medium to High	Medium to Low	Low	High
Potential Impacts of Appropriate Remedies[1] - Safety [257.96(c)(1)]	Low to Medium	Low to Medium	Medium	Medium	Medium
Potential Impacts of Appropriate Remedies[1] - Cross-Media [257.96(c)(1)]	Medium	Low	Medium	Low to Medium	Low to Medium
Potential Impacts of Appropriate Remedies Control of Exposure to Residual Contamination[1] [257.96(c)(1)]	Medium to High	High	Medium	Medium to High	High
Time Required to Begin Remedy[2] [257.96(c)(2)]	Short	Existing soil-only cover system - Short Composite final cover system - Short	Medium (~ 1 to 2 years)	Medium (~ 2 to 3 years)	Short
Time Required to Complete Remedy[2] [257.96(c)(2)]	Short	Existing soil-only cover system - Short Composite final cover system - Medium (~ 3 years)	Currently Unknown	Currently Unknown	Long - Additional monitoring and wells would be necessary to confirm that the GWPS is not being exceeded on a seasonal basis.
Institutional Requirements (State and Local Permits and Other Approvals)[3] [257.96(c)(3)]	Minimal	Minimal to Moderate	Extensive to Moderate	Moderate	Minimal

Notes:

1. Subjective ratings of “Low”, “Medium”, or “High” assigned based on how the potential corrective measures are anticipated to satisfy each evaluation criterion:
   Performance: Effectiveness in reducing lithium concentrations in groundwater.
   Reliability: Effectiveness in consistently reducing lithium concentrations in groundwater.
   Ease of Implementation: Ease in being installed to begin reducing lithium concentrations in groundwater.
   Safty Impacts: Likelihood that illness, injury, or death directly related to the potential corrective measure would occur during construction or operations.
   Cross-Media Impacts: Likelihood that the potential corrective measure will result in a transfer of contaminants to the air, surface water, or soil, either from a direct discharge or from management of treatment residuals.
   Control of Exposure: Likelihood that that the potential corrective measure will result in exposure of contaminants to human or environmental receptors either from a direct discharge or from management of treatment residuals.
2. Subjective ratings of “Short”, “Medium”, or “Long” assigned with regard to the anticipated time for each potential corrective measure to reduce lithium concentrations in groundwater, accounting for factors such as the complexity of the design, construction, and permitting efforts, as well as forecasting how efficient the technology is expected to be in achieving remedial goals.
3. Subjective ratings of “Minimal”, “Moderate”, and “Extensive” assigned with regard to the anticipated level of effort that will be needed to obtain the permits/approvals which may be required by PADEP or local authorities for each potential corrective measure.

FIGURES

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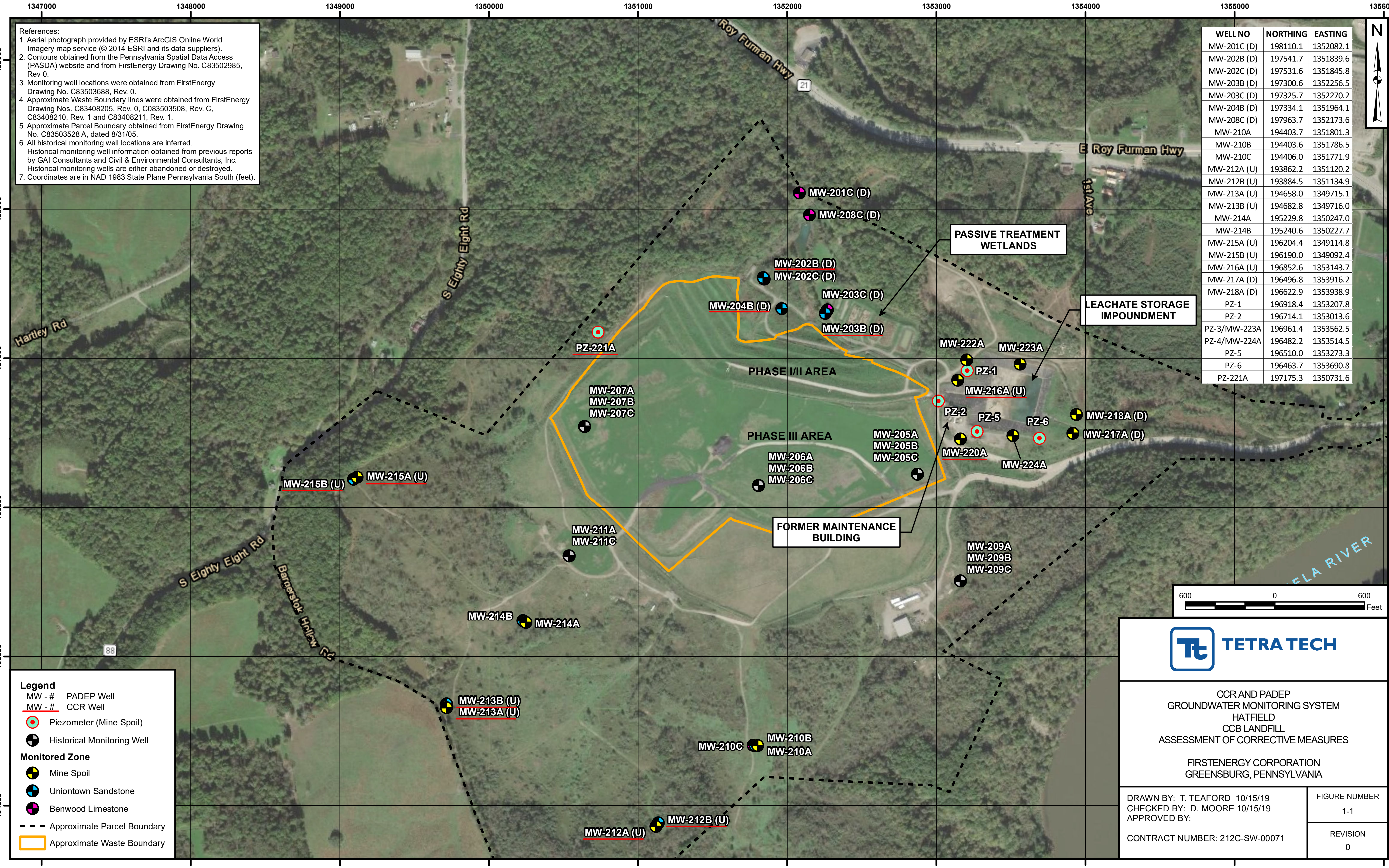

References:
1. Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2014 ESRI and its data suppliers).
2. Contours obtained from the Pennsylvania Spatial Data Access (PASDA) website and from FirstEnergy Drawing No. C83502985, Rev 0.
3. Monitoring well locations were obtained from FirstEnergy Drawing No. C83503688, Rev. 0.
4. Approximate Waste Boundary lines were obtained from FirstEnergy Drawing Nos. C83408205, Rev. 0, C083503508, Rev. C, C83408210, Rev. 1 and C83408211, Rev. 1.
5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C83503528 A, dated 8/31/05.
6. All historical monitoring well locations are inferred. Historical monitoring well information obtained from previous reports by GAI Consultants and Civil & Environmental Consultants, Inc. Historical monitoring wells are either abandoned or destroyed.
7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

WELL NO	NORTHING	EASTING
MW-201C (D)	198110.1	1352082.1
MW-202B (D)	197541.7	1351839.6
MW-202C (D)	197531.6	1351845.8
MW-203B (D)	197300.6	1352256.5
MW-203C (D)	197325.7	1352270.2
MW-204B (D)	197334.1	1351964.1
MW-208C (D)	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A (U)	193862.2	1351120.2
MW-212B (U)	193884.5	1351134.9
MW-213A (U)	194658.0	1349715.1
MW-213B (U)	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A (U)	196204.4	1349114.8
MW-215B (U)	196190.0	1349092.4
MW-216A (U)	196852.6	1353143.7
MW-217A (D)	196496.8	1353916.2
MW-218A (D)	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend
MW - # PADEP Well
MW - # CCR Well
Piezometer (Mine Spoil)
Historical Monitoring Well

Monitored Zone
Mine Spoil
Uniontown Sandstone
Benwood Limestone
Approximate Parcel Boundary
Approximate Waste Boundary

TETRA TECH

CCR AND PADEP
GROUNDWATER MONITORING SYSTEM
HATFIELD
CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: T. TEAFORD 10/15/19
CHECKED BY: D. MOORE 10/15/19
APPROVED BY:
CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 1-1
REVISION 0

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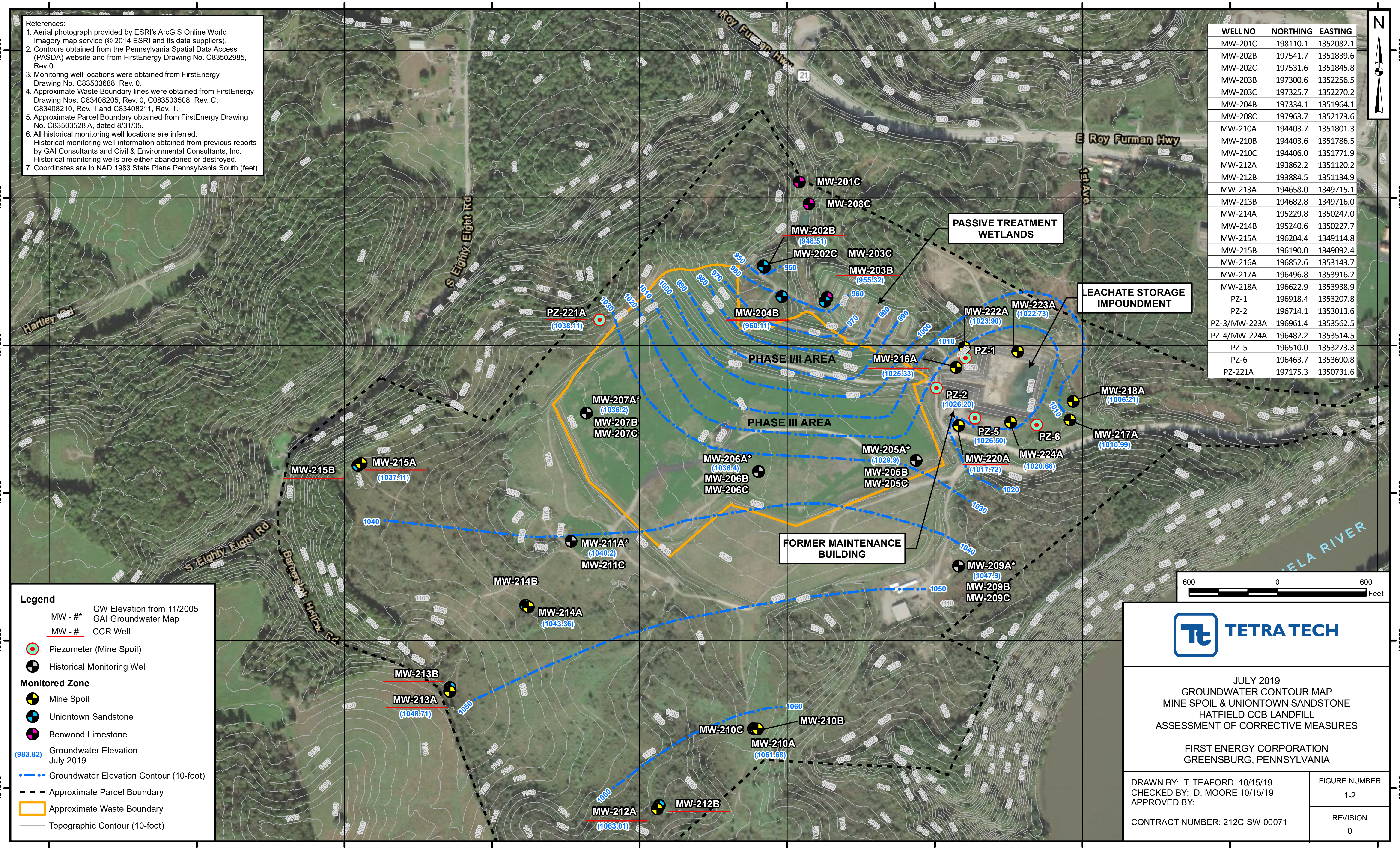

WELL NO	NORTHING	EASTING
MW-201C	198110.1	1352082.1
MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A	193862.2	1351120.2
MW-212B	193884.5	1351134.9
MW-213A	194658.0	1349715.1
MW-213B	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
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6. All historical monitoring well locations are inferred. Historical monitoring well information obtained from previous reports by GAI Consultants and Civil & Environmental Consultants, Inc. Historical monitoring wells are either abandoned or destroyed.
7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

Legend

- MW - #* GW Elevation from 11/2005 GAI Groundwater Map
- MW - # CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Zone

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- (983.82) Groundwater Elevation July 2019
- Groundwater Elevation Contour (10-foot)
- Approximate Parcel Boundary
- Approximate Waste Boundary
- Topographic Contour (10-foot)

TETRA TECH

JULY 2019
GROUNDWATER CONTOUR MAP
MINE SPOIL & UNIONTOWN SANDSTONE
HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: T. TEAFORD 10/15/19
CHECKED BY: D. MOORE 10/15/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 1-2

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).
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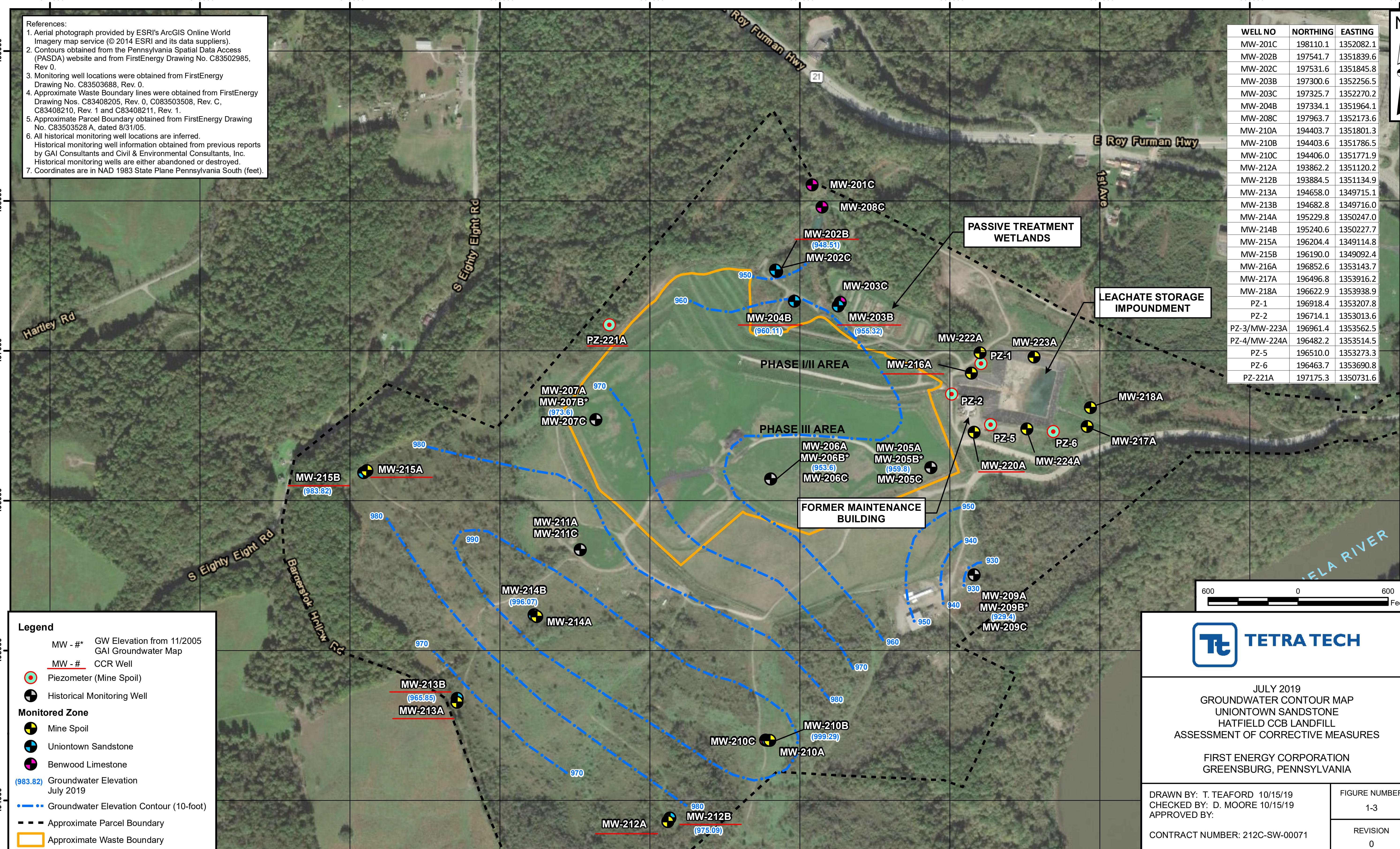

WELL NO	NORTHING	EASTING
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MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A	193862.2	1351120.2
MW-212B	193884.5	1351134.9
MW-213A	194658.0	1349715.1
MW-213B	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

MW - #* GW Elevation from 11/2005 GAI Groundwater Map
MW - # CCR Well
Piezometer (Mine Spoil)
Historical Monitoring Well

Monitored Zone

Mine Spoil
Uniontown Sandstone
Benwood Limestone
(983.82) Groundwater Elevation July 2019
Groundwater Elevation Contour (10-foot)
Approximate Parcel Boundary
Approximate Waste Boundary

TETRA TECH

JULY 2019
GROUNDWATER CONTOUR MAP
UNIONTOWN SANDSTONE
HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: T. TEAFORD 10/15/19
CHECKED BY: D. MOORE 10/15/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 1-3

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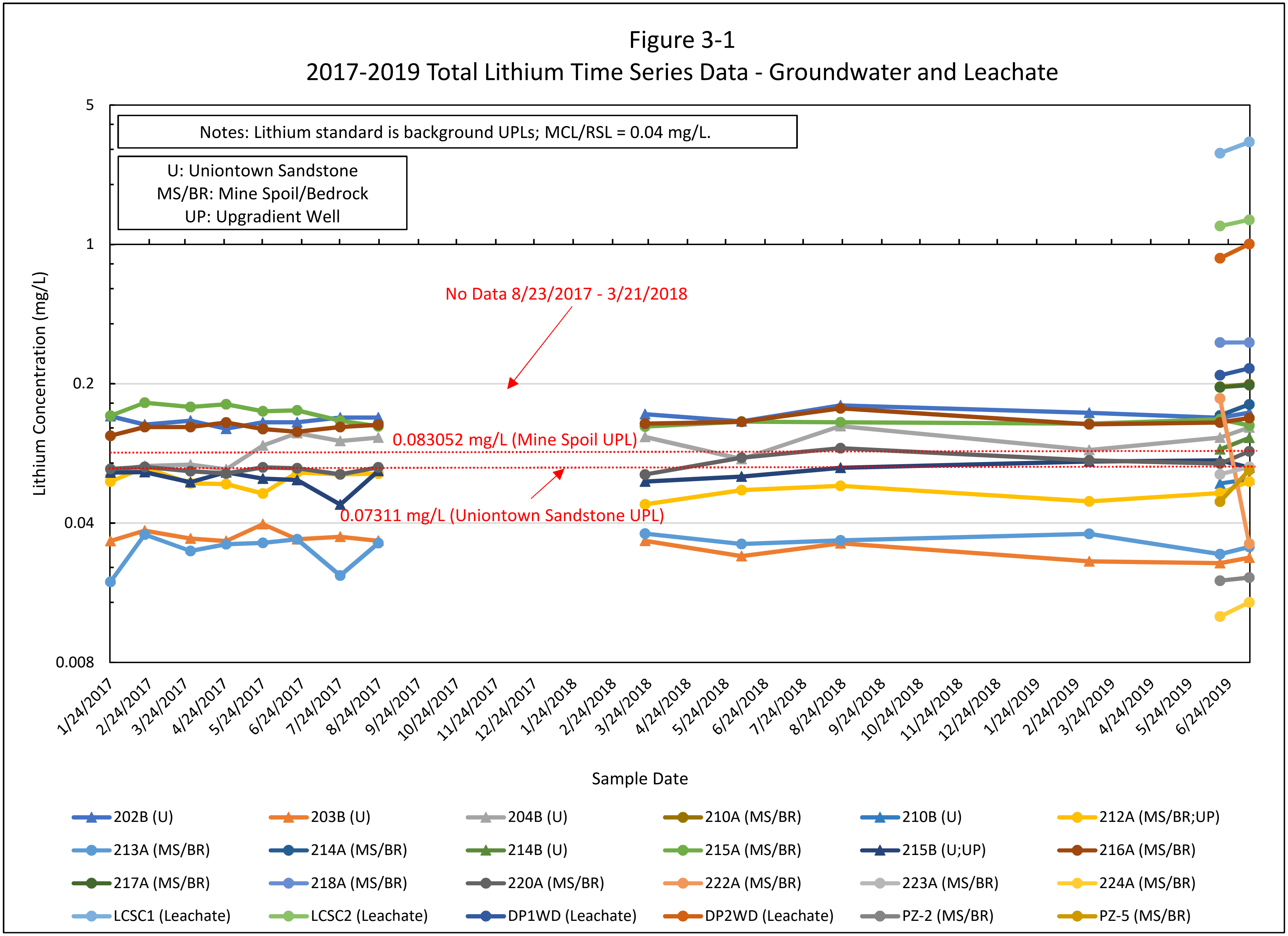

Figure 3-1
2017-2019 Total Lithium Time Series Data - Groundwater and Leachate
Notes: Lithium standard is background UPLs; MCL/RSL = 0.04 mg/L.
U: Uniontown Sandstone
MS/BR: Mine Spoil/Bedrock
UP: Upgradient Well
No Data 8/23/2017 - 3/21/2018
0.083052 mg/L (Mine Spoil UPL)
0.07311 mg/L (Uniontown Sandstone UPL)
Lithium Concentration (mg/L)
5
1
0.2
0.04
0.008
1/24/2017
2/24/2017
3/24/2017
4/24/2017
5/24/2017
6/24/2017
7/24/2017
8/24/2017
9/24/2017
10/24/2017
11/24/2017
12/24/2017
1/24/2018
2/24/2018
3/24/2018
4/24/2018
5/24/2018
6/24/2018
7/24/2018
8/24/2018
9/24/2018
10/24/2018
11/24/2018
12/24/2018
1/24/2019
2/24/2019
3/24/2019
4/24/2019
5/24/2019
6/24/2019
Sample Date
202B (U)
203B (U)
204B (U)
210A (MS/BR)
210B (U)
212A (MS/BR;UP)
213A (MS/BR)
214A (MS/BR)
214B (U)
215A (MS/BR)
215B (U;UP)
216A (MS/BR)
217A (MS/BR)
218A (MS/BR)
220A (MS/BR)
222A (MS/BR)
223A (MS/BR)
224A (MS/BR)
LCSC1 (Leachate)
LCSC2 (Leachate)
DP1WD (Leachate)
DP2WD (Leachate)
PZ-2 (MS/BR)
PZ-5 (MS/BR)

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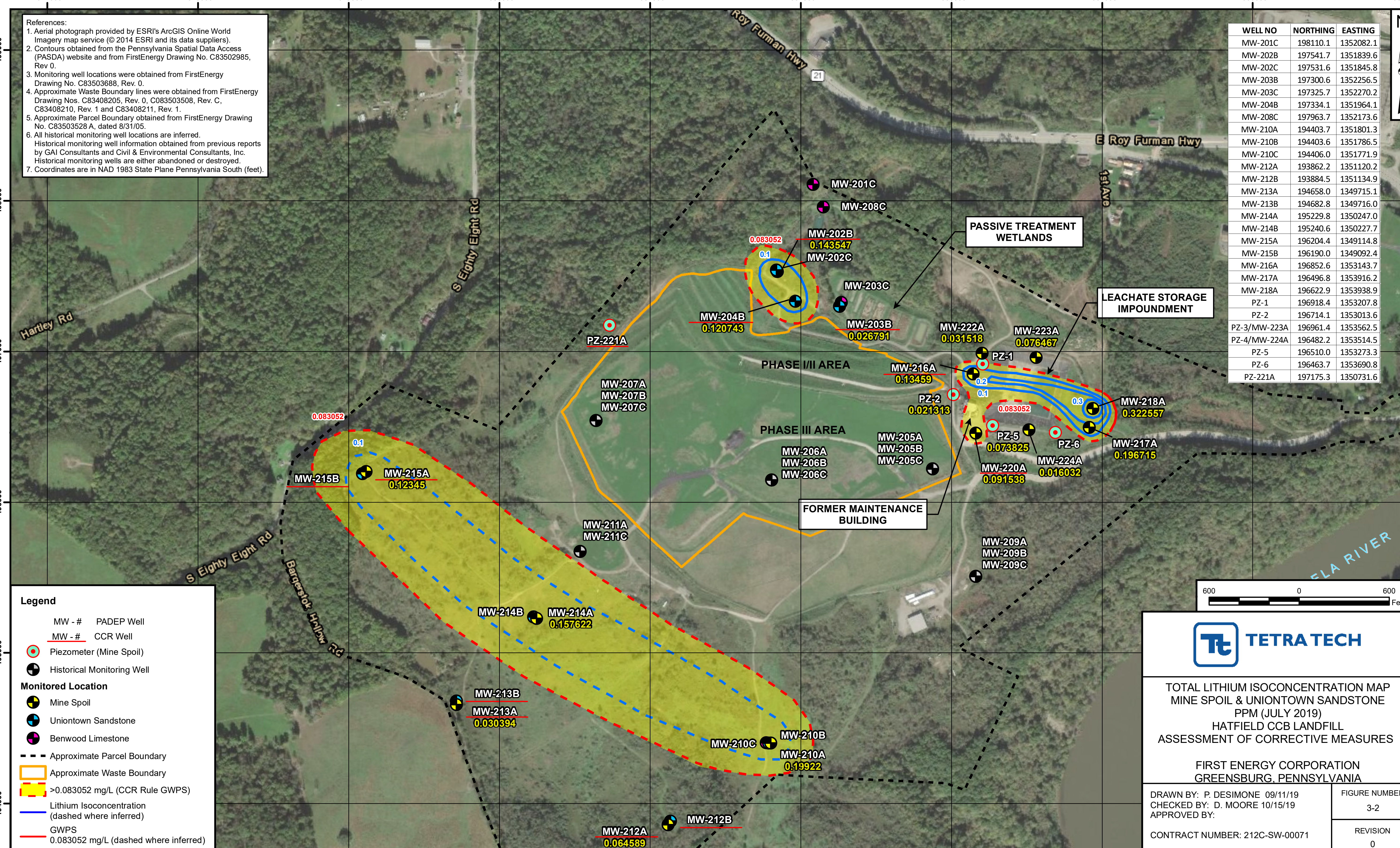

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MW-202C	197531.6	1351845.8
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MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
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MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
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MW-212B	193884.5	1351134.9
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MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
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PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

- MW - # PADEP Well
- MW - # CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Location

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- Approximate Parcel Boundary
- Approximate Waste Boundary
- >0.083052 mg/L (CCR Rule GWPS)
- Lithium Isoconcentration (dashed where inferred)
- GWPS 0.083052 mg/L (dashed where inferred)

TETRA TECH

TOTAL LITHIUM ISOCONCENTRATION MAP
MINE SPOIL & UNIONTOWN SANDSTONE
PPM (JULY 2019)
HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 10/15/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 3-2

REVISION 0

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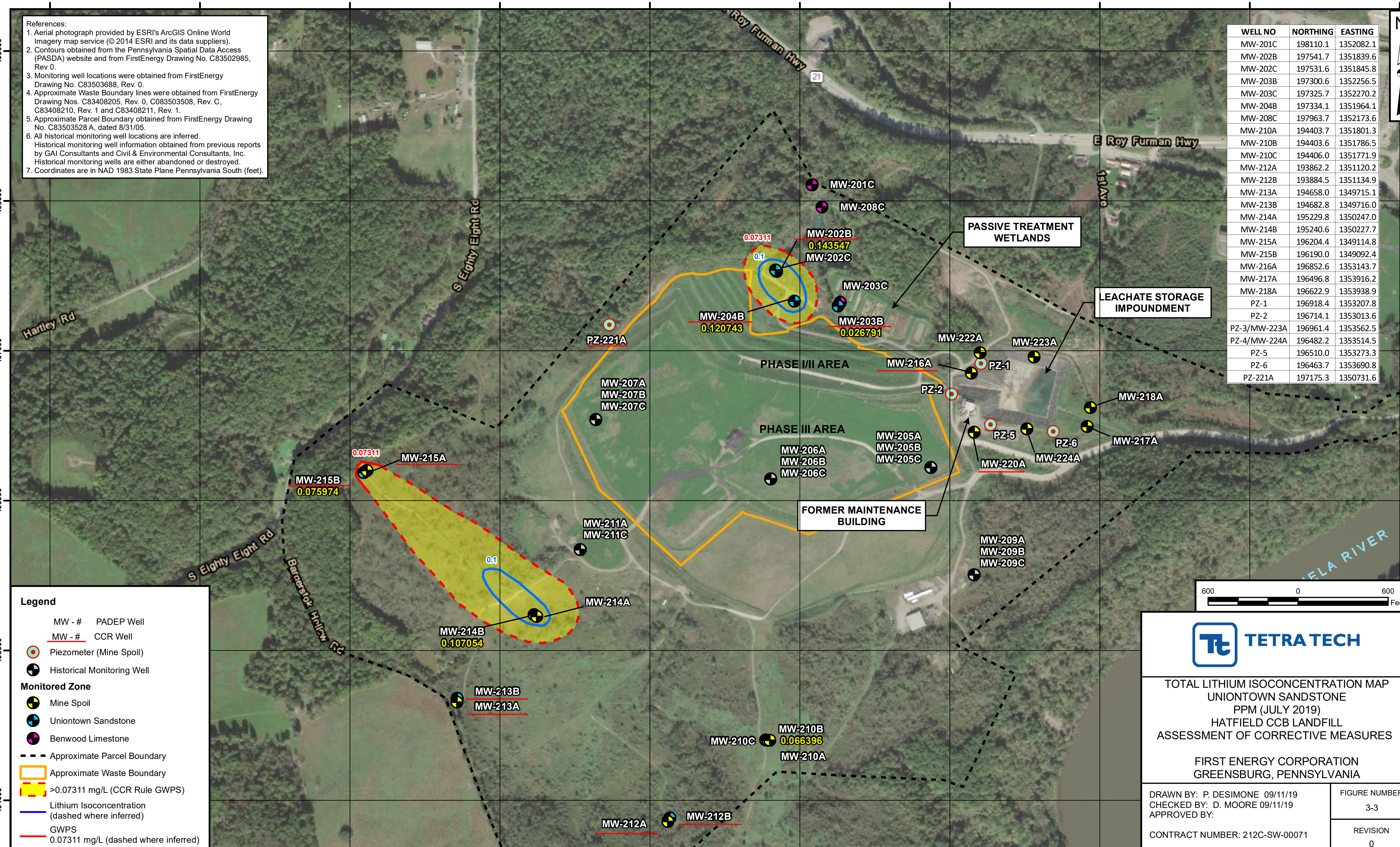

References:
1. Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2014 ESRI and its data suppliers).
2. Contours obtained from the Pennsylvania Spatial Data Access (PASDA) website and from FirstEnergy Drawing No. C83502985, Rev 0.
3. Monitoring well locations were obtained from FirstEnergy Drawing No. C83503688, Rev. 0.
4. Approximate Waste Boundary lines were obtained from FirstEnergy Drawing Nos. C83408205, Rev. 0, C083503508, Rev. C, C83408210, Rev. 1 and C83408211, Rev. 1.
5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C83503528 A, dated 8/31/05.
6. All historical monitoring well locations are inferred. Historical monitoring well information obtained from previous reports by GAI Consultants and Civil & Environmental Consultants, Inc. Historical monitoring wells are either abandoned or destroyed.
7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

WELL NO	NORTHING	EASTING
MW-201C	198110.1	1352082.1
MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A	193862.2	1351120.2
MW-212B	193884.5	1351134.9
MW-213A	194658.0	1349715.1
MW-213B	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

MW - # PADEP Well
MW - # CCR Well
Piezometer (Mine Spoil)
Historical Monitoring Well

Monitored Zone

Mine Spoil
Uniontown Sandstone
Benwood Limestone
Approximate Parcel Boundary
Approximate Waste Boundary
>0.07311 mg/L (CCR Rule GWPS)
Lithium Isoconcentration (dashed where inferred)
GWPS 0.07311 mg/L (dashed where inferred)

TETRA TECH

TOTAL LITHIUM ISOCONCENTRATION MAP
UNIONTOWN SANDSTONE
PPM (JULY 2019)
HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

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FIGURE NUMBER 3-3
REVISION 0

TETRA TECH

FIGURE 4-1
GROUNDWATER DRINKING WATER SUPPLY WELLS MAP (FORM 2R)
HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

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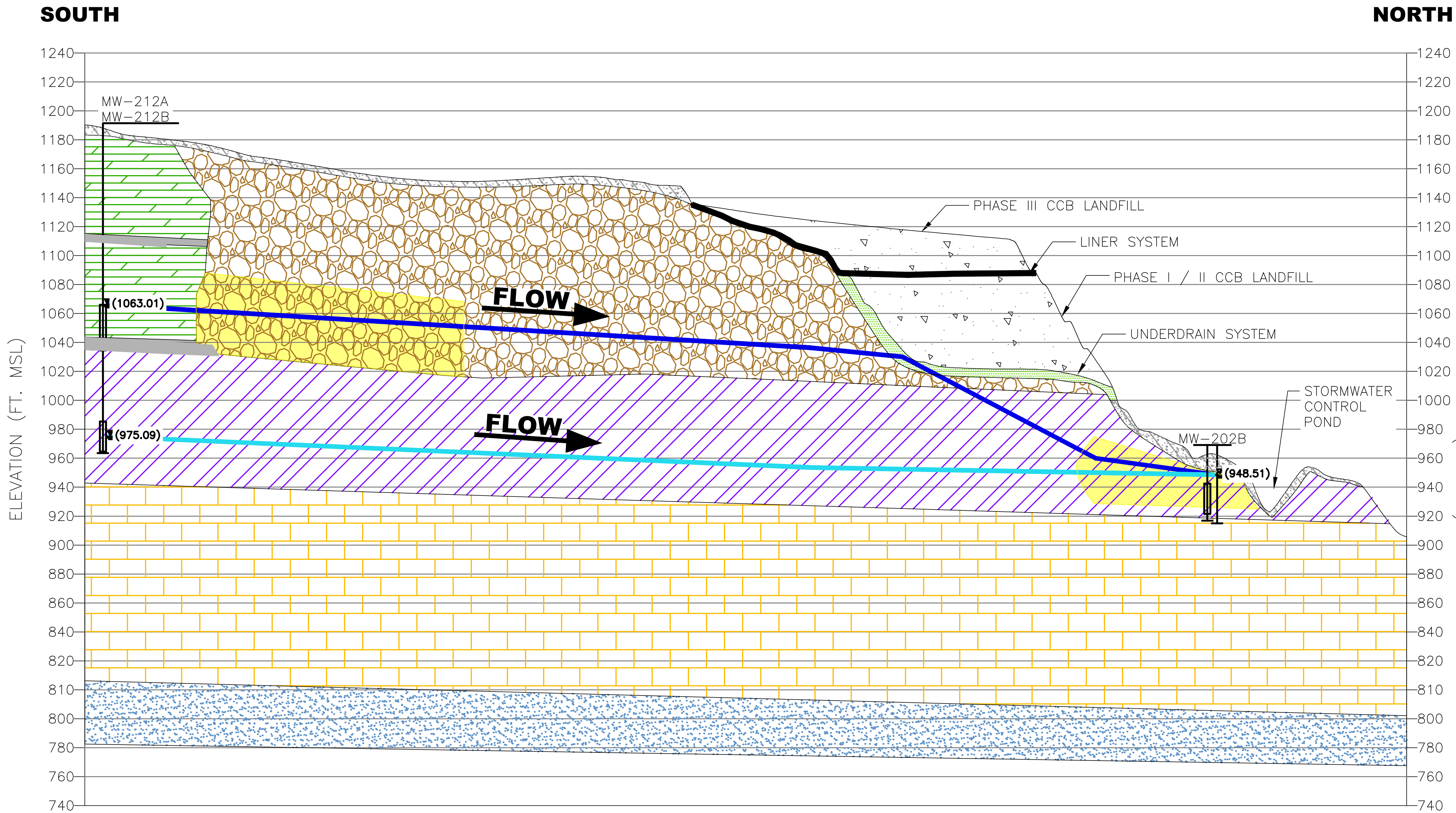
GREENSBURG, PENNSYLVANIA



NOTES

1. JULY 2019 GROUNDWATER ELEVATIONS SHOWN.

LEGEND

- MINE SPOIL/ WEATHERED BEDROCK AQUIFER
- UNIONTOWN SANDSTONE AQUIFER
- PHASE III LINER SYSTEM
- GWPS EXCEEDANCE FOR LITHIUM
- CLAYEY SILT TRACE ROCK FRAGMENTS
- MINE SPOIL
- CCB LANDFILL
- PHASE I/II UNDERDRAIN SYSTEM
- WAYNESBURG COALS
- WAYNESBURG FORMATION
- UNIONTOWN FORMATION
- BENWOOD LIMESTONE
- SEWICKLEY SANDSTONE

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GREENSBURG, PENNSYLVANIA

HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

GREENE COUNTY, PENNSYLVANIA

CONCEPTUAL SITE MODEL (CSM) - NORTHERN FLOW

NOT TO SCALE

DATE:	10/15/19
PROJECT NO.:	212C-SW-00071
DESIGNED BY:	DS
DRAWN BY:	NN
CHECKED BY:	DS

FIGURE 4-2

SHEET 1 OF 1

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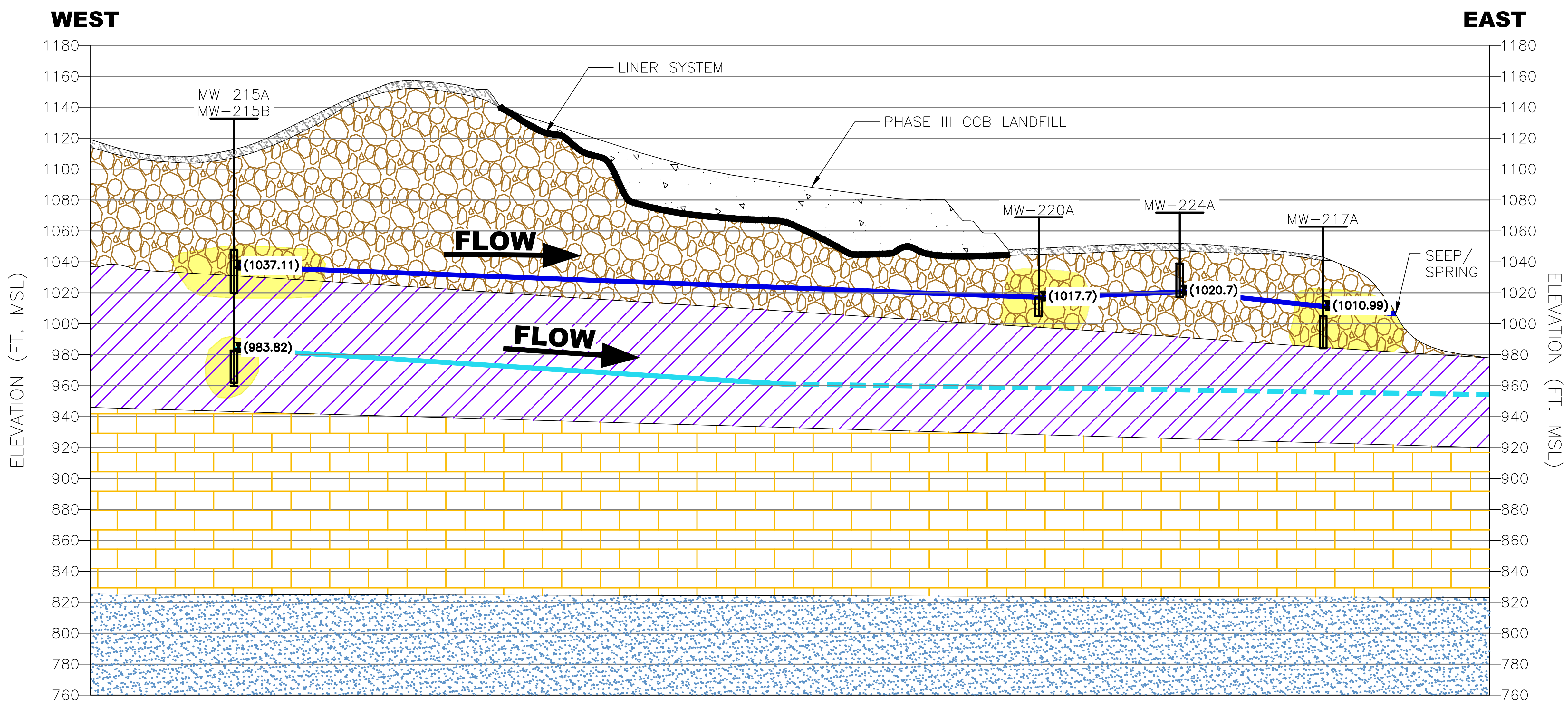

NOTES

1. JULY 2019 GROUNDWATER ELEVATIONS SHOWN.

LEGEND

- MINE SPOIL/ WEATHERED BEDROCK AQUIFER
- UNIONTOWN SANDSTONE AQUIFER
- PHASE III LINER SYSTEM
- GWPS EXCEEDANCE FOR LITHIUM
- CLAYEY SILT TRACE ROCK FRAGMENTS
- CCB LANDFILL
- MINE SPOIL
- UNIONTOWN FORMATION
- BENWOOD LIMESTONE
- SEWICKLEY SANDSTONE

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HATFIELD CCB LANDFILL
ASSESSMENT OF CORRECTIVE MEASURES

GREENE COUNTY, PENNSYLVANIA

CONCEPTUAL SITE MODEL (CSM) - EASTERN FLOW

NOT TO SCALE

DATE:	10/15/19
PROJECT NO.:	212C-SW-00071
DESIGNED BY:	DS
DRAWN BY:	NN
CHECKED BY:	DS

FIGURE 4-3

SHEET 1 OF 1

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APPENDIX A

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

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

Coal Combustion Byproduct Landfill

Hatfield's Ferry Power Station
Greene County, Pennsylvania

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-00071

October 2019

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

COAL COMBUSTION BYPRODUCT LANDFILL

HATFIELD'S FERRY POWER STATION
GREENE COUNTY, PENNSYLVANIA

Prepared for:

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Tetra Tech Project No. 212C-SW-00071

October 2019

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1.0 INTRODUCTION/BACKGROUND

FirstEnergy (FE) owns the coal-fired Hatfield's Ferry Power Station (hereinafter referred to as the "Station") located in Greene County, Pennsylvania. The Station has been closed since 2013 but, historically, Coal Combustion Residuals (CCRs) produced at the Station were placed in the facility's captive dry disposal landfill (referred to as the Coal Combustion Byproduct Landfill or "CCBL"), which is located approximately one mile west-southwest of the Station. The landfill is regulated under Pennsylvania Department of Environmental Protection (PADEP) Solid Waste Permit No. 300370, 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"). Although CCR waste generation ceased when the Station closed in 2013, a September 2015 modification to the permit allowed coal combustion wastes generated at other FE facilities to be disposed at the CCBL; however, no disposal from any other facilities has occurred to date. Because of its potential to begin receiving CCRs again in the future, the landfill is categorized under the Rule as an active CCR unit and is subject to the groundwater monitoring requirements of 40 CFR §§ 257.90 through 257.98.

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), results and findings from the 2017 groundwater monitoring program were documented in the 2017 Annual Groundwater Monitoring and Corrective Action Report (2017 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). Subsequent to the monitoring period documented in that report, Statistically Significant Increases (SSIs) for boron, calcium, chloride, pH, sulfate, and total dissolved solids (TDS) were determined. Based on the various parameters for which SSIs were identified, an Appendix III ASD was undertaken as discussed in the 2018 AGWMCA Report (Tetra Tech, 2019). However, all 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, FirstEnergy 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 March 2018, with laboratory analysis and data validation completed by May 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 Assessment Monitoring 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 June and August 2018. Pursuant to §§ 257.94(e)(3), 257.105(h)(5), and 257.106(h)(4), a notice was prepared and posted to the facility's Operating Record and issued to the PADEP 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 August (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 existed at Statistically Significant Levels (SSLs) above applicable Groundwater Protection Standards (GWPS). The CCR Rule Appendix IV parameters determined in the downgradient monitoring wells (labeled "MW-#") to be above their respective GWPS are summarized in the following table:

	Mine Spoil / Weathered Bedrock (Upgradient Well MW-212A)		**Uniontown Sandstone (Upgradient Well MW-215B)**	
Appendix IV Parameters	**MW-216A (mg/L)**	**MW-220A (mg/L)**	**MW-202B (mg/L)**	**MW-204B (mg/L)**
Cobalt (Co)	**GWPS = 0.00849**		**GWPS = 0.00806**	
AM-1	0.37723	0.09809	< GWPS	< GWPS
AM-2	0.43337	0.11075	< GWPS	< GWPS
AM-3	0.48736	0.12682	< GWPS	< GWPS
Lithium (Li)	**GWPS = 0.083052**		**GWPS = 0.07311**	
AM-1	0.12895	0.08520	0.12968	0.08379
AM-2	0.15065	0.09511	0.15577	0.12274
AM-3	0.12378	< GWPS	0.14286	0.09308

In accordance with 40 CFR § 257.106(h)(6), a notice was prepared and posted to the facility's Operating Record, issued to the PADEP, and then posted on the facility's publicly accessible website in April 2019, to provide notification of the SSLs for cobalt and lithium 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 and AM-2 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 could not be completed within the 90-day timeframe. 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 PADEP, and then posted on the facility's publicly accessible website in April 2019, to provide notification of the initiation of an ACM for cobalt and lithium at the Site.

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

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 AM 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. These checklists include:

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

For this ASD all three checklists were completed. 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;
- Potential for mine spoil impacts; and
- Potential for impacts related to historical maintenance activities conducted on-site.

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. Referring to Table 1 it's seen that for most potential sampling, laboratory, or statistical evaluation causes, no instances/issues/indications were identified. For those 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, sampling, laboratory analysis, and statistical evaluations are not demonstrable alternative sources of the Appendix IV SSLs determined for the AM-1, -2, and -3 events.

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 (specifically for lithium and cobalt) for the CCR unit provided by FE, and hydrogeologic and design information and data included in *CCR Rule Groundwater Monitoring System Evaluation Report for The Hatfield's Ferry 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 June and July 2019 sampling events at the CCR unit (four locations – DP1WD, DP2WD, LCSC1, AND LCSC2), in which lithium and cobalt (not historically sampled for at the Site) were added to the leachate sampling parameter list, were compared against the July 2019 groundwater monitoring well analytical results developed as part of nature and extent of release (N&E) sampling (these results are

provided in Table 4 of this report). The comparison of leachate data indicates that the SSLs for cobalt in the mine spoil/weathered bedrock combined aquifer are likely attributable to an alternative source as concentrations in downgradient wells MW-216A and MW-220A are higher than those in both the upgradient well MW-212A and the average of the applicable leachate samples. Alternatively, concentrations of lithium in leachate samples are orders of magnitude higher than those of background and downgradient wells in both the mine spoil/weathered bedrock combined aquifer and Uniontown Sandstone aquifer indicating that the lithium SSLs in groundwater are likely attributable to a release from the CCR Unit. These leachate results and associated comparisons are attached as Table 5 of this report.

- Site Hydrogeology - As discussed in the *CCR Rule Groundwater Monitoring System Evaluation Report* (Tetra Tech, 2017), groundwater in the CCBL area occurs primarily within a layer of surficial mine spoil and underlying fractured bedrock of the Monongahela Group. The uppermost aquifer in the CCBL area is, collectively, the mine spoil/weathered bedrock aquifer (shallow aquifer) and the underlying Uniontown sandstone aquifer which form a single, interconnected flow unit along the northern end of the site. As shown on Figure 1, the CCR groundwater monitoring well network at the site consists of three upgradient (background) wells in the mine spoil/bedrock aquifer (MW-212A, -213A, and -215A), three upgradient (background) wells in the Uniontown sandstone aquifer (MW-212B, -213B, and -215B), five downgradient wells to monitor the combined aquifer (MW-216A, -220A, -202B, -203B, and -204B), and one piezometer (PZ-221A). As detailed in the 2017 and 2018 AGWMCA Reports (Tetra Tech 2018 and 2019, respectively), MW-212A is currently used for interwell comparisons due to its overall lower UPLs, and MW-215B is currently used for interwell comparisons due to MW-212B and -213B often having insufficient water available for sampling. Based on historic and recent groundwater data from the site wells, groundwater flow within the mine spoil/weathered bedrock aquifer is primarily to the north along the slope of the top of bedrock, with a portion of the shallow groundwater along the northeast side of the CCBL flowing eastward as shown on Figure 2. Groundwater in the Uniontown sandstone aquifer migrates primarily to the northeast and east towards outcrop areas along major drainage features in the area as shown on Figure 3. Geologic and hydrogeologic characteristics of the site and the CCR monitoring well network are both discussed in greater detail in the above-referenced report.
- CCR Unit Design - As shown on Figure 1, the CCR unit consists of three permitted disposal areas: Phases I, II, and III. The Phase I and II areas are unlined but do include

an underdrain blanket system and are largely overlain by the Phase III area, which has a Pennsylvania Class I Residual Solid Waste liner system that includes two geomembranes, a geosynthetic clay liner (GCL), a leachate collection system, and a leak detection zone. Disposal operations were performed in the Phase I and II areas until 2010, at which time all operations were transitioned to the Phase III area. Underdrain flows collected from the Phase I and II areas are routed to two concrete sumps where they are then pumped to a passive wetland treatment system located northeast of the Phase II disposal area. Surface water runoff and leachate collected from the Phase III area are routed to the landfill's Leachate Storage Impoundment (LSI), which is located east of the Phase II and Phase III disposal areas. Like the Phase III area, the LSI has a Class I liner system.

Based on the LOE findings presented in Table 2, the lithium SSLs determined for the AM-1, -2, and -3 events can most likely be attributed to a release from the CCR unit, while the cobalt SSLs can most likely be attributed to a source other than the CCR unit.

3.3 ASD CHECKLIST 3

ASD Checklist 3 is attached as Table 3 of this report. The checklist evaluations were performed in a similar manner 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 (specifically for lithium and cobalt) for the CCR unit provided by FE, and hydrogeologic and design information and data included in *CCR Rule Groundwater Monitoring System Evaluation Report for The Hatfield's Ferry 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 from the site-wide N&E of release sampling (Table 4) that was performed to evaluate the mine spoil and/or other alternative sources of cobalt and lithium SSLs, indicate the source of cobalt is emanating from the vicinity of the LSI and former maintenance building area, near downgradient wells MW-216A and MW-220A. Historical activities conducted at the building and surrounding area included mechanical maintenance and repair of heavy earthmoving equipment (dump trucks, excavators, bulldozers, etc.), support vehicles, and ancillary equipment (e.g., pumps). These types of activities are noted in the EPRI 2017 ASD guidance document as being potential alternate sources of cobalt. Based on the location of these historic activities directly upgradient of the wells with cobalt SSLs, they are likely the sources of cobalt in this area. These results

and associated comparisons are discussed in greater detail in Sections 3.5 and 3.6 of this report.

Based on the LOE findings presented in Table 3, the lithium SSLs determined for the AM-1, -2, and -3 events can most likely be attributed to a release from the CCR unit, while the cobalt SSLs can most likely be attributed to a source other than the CCR unit.

3.4 REGIONAL GROUNDWATER STUDY

As previously noted, the monitored CCR aquifer consists of a combination of the mine spoil /weathered bedrock aquifer and the fractured bedrock of the Uniontown sandstone. While there is a brief discussion of the impact of historical surface mining on groundwater quality in this section, the interpreted impact of mine spoil on the monitored aquifer is discussed in greater detail in the following section of this report. In an effort to evaluate the natural variation in groundwater quality in the Uniontown sandstone relative to SSI constituents, the *Water Resources and the Effects of Coal Mining, Greene County, Pennsylvania, Water Resources Report 63* (PaDER, 1987a) was reviewed. This is referred to as the “subject report” below. Also reviewed was the *Geologic Map of Greene County, Pennsylvania, Showing the Locations of Wells, Springs, and Hydrologic Sampling and Testing Sites* (PaDER, 1987b).

As noted in Section 1.0, for downgradient wells screened in the Uniontown sandstone, SSLs for lithium were identified during the AM-1, -2, and -3 sampling events. The subject report had minimal information on groundwater quality for the Uniontown sandstone, particularly with regard to this SSL constituent.

3.5 MINE SPOIL

As discussed in in the *CCR Rule Groundwater Monitoring System Evaluation Report* (Tetra Tech, 2017), the original topography of the CCBL area has been altered by surface mining of the Waynesburg coal that was performed during the 1970s and 1980s throughout much of the central portion of the permitted site. Mine spoil, in some cases mixed with fly ash, was used as backfill for mined areas, and comprises the unconsolidated subsurface materials across most of the site, including those beneath the existing Phase I, II, and III landfill and the areas upgradient of the existing Phase I, II, and III landfill. The mine spoil consists of sandstone, mudstone and limestone-derived rock fragments ranging in size from soil-sized particles to cobble/boulder-sized rock fragments and varies in thickness from a few feet to over 100 feet across the permitted CCBL area. During permitting and design of the Phase III disposal area, thirteen monitoring wells were installed within the mine spoil/weathered bedrock aquifer to support the initial

geologic/hydrogeologic characterization of the site. The locations of these wells are shown on Figure 1 and they are denoted with an "A" suffix in their identification numbers. Five of these wells (MW-205A, -206A, -207A, -209A, and -211A) have since been abandoned as they were situated within the footprint of the Phase III landfill, two others (MW-210A and -214A) were rendered inactive once the hydrogeologic site characterization was complete, and another two (MW-217A and -218A) are positioned such that they're downgradient of the LSI and not the landfill. As seen on Figure 1, the wells that are inactive or that have been abandoned are located between the CCR monitoring program upgradient wells MW-212A, -213A, and -215A and downgradient wells MW-216A, -220A, -202B, -203B, and -204B.

To evaluate the potential of the mine spoil as a source of the cobalt and lithium SSLs identified during the AM sampling events, historical groundwater data for the CCR unit dating back to 2005 was reviewed. However, neither cobalt nor lithium analyses were completed during that time as those constituents were not required under the facility's PADEP groundwater monitoring program. The current CCR data set was therefore augmented with additional analytical data from active and inactive PADEP monitoring wells located upgradient and downgradient of the CCR unit. These wells were sampled during June and July of 2019 as part of N&E of release activities in the event that this ASD Report determined that the CCR unit was the source of the SSLs or that further delineation of lithium and cobalt concentrations in groundwater proved necessary.

Site-wide groundwater analytical results indicate that lithium is present in mid-gradient wells (MW-214A and MW-210A) for the mine spoil/combined aquifer at concentrations greater than the upgradient well MW-212A UPL, but lower than the applicable leachate average (refer to Table 4). This indicates that fly ash mixed within the mine spoil during reclamation activities may present a component of lithium in mine spoil/weathered bedrock groundwater as shown on Figure 4. Additionally, lithium concentrations greater than the Uniontown Sandstone aquifer upgradient well UPL were observed in numerous mid-gradient wells, indicating the lithium impacts in the shallower mine spoil/weathered bedrock combined aquifer may be vertically migrating down into the Uniontown Sandstone as shown on Figure 5.

In summary, the data for lithium indicates moderate potential for the mine spoil to be a source of the SSLs identified; however, due to historical changes in the mine spoil/weathered bedrock combined aquifer flow paths (that could have occurred during on-site mining activities) in combination with the orders of magnitude higher lithium concentrations in leachate, the CCR unit cannot be ruled out as the likely source of the lithium SSLs. The data for cobalt indicate a low

potential for the mine spoil to be a source of the SSLs identified, however, an alternative source as discussed in Section 3.6 is likely.

3.6 HISTORICAL MAINTENANCE ACTIVITIES NEAR THE LSI

To evaluate the potential of historical maintenance activities near downgradient monitoring wells MW-216A and MW-220A as a potential source of the cobalt SSLs identified during the AM-1, -2, and -3 sampling events, historical groundwater data for the CCR unit dating back to 2005 was reviewed; however, cobalt analyses were not completed during that time as that constituent was not required under the facility's PADEP groundwater monitoring program. As such, the current CCR data set was augmented with additional analytical data from active and inactive PADEP monitoring wells located upgradient and downgradient of the CCR unit. These wells were sampled during June and July of 2019 as part of N&E of release activities in the event that this ASD Report determined that the CCR unit was the source of the SSLs or that further delineation of cobalt concentrations in groundwater proved necessary.

Site-wide groundwater analytical results indicate that cobalt is only present in downgradient wells around the LSI within the mine spoil/combined aquifer at concentrations greater than the upgradient well MW-212A UPL, while also being higher than the applicable leachate average for cobalt (refer to Table 5). These results indicate that the source of cobalt is emanating from the vicinity of the former maintenance building as shown on Figure 6. Historical activities conducted at the building and surrounding area included mechanical maintenance and repair of heavy earthmoving equipment (dump trucks, excavators, bulldozers, etc.), support vehicles, and ancillary equipment (e.g., pumps). These types of activities are noted in the EPRI 2017 ASD guidance document as being potential alternate sources of cobalt. Based on the location of these historic activities directly upgradient of the wells with cobalt SSLs, they are likely the sources of cobalt in this area.

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 lithium SSLs in both the mine spoil/weathered bedrock combined aquifer and Uniontown Sandstone aquifer that were identified for the AM-1, -2, and -3 events 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 lithium per § 257.96 of the CCR Rule appears to be warranted and assessment monitoring will continue.

The SSLs for cobalt that were identified in the mine spoil/weathered bedrock combined aquifer during the AM-1, -2, and -3 events are attributed to sources other than the CCR unit. As such, in accordance with the applicable requirements of § 257.95 of the CCR rule, no corrective measures are required and assessment monitoring for cobalt will continue.

5.0 REFERENCES

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Tetra Tech, 2018. *2017 Annual CCR Groundwater Monitoring and Corrective Action Report, Coal Combustion Byproduct Landfill, Hatfield's Ferry Power Station*. Tetra Tech, Inc., Pittsburgh, PA, January 2018. http://ccrdocs.firstenergycorp.com/

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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 lab identifiers and COCs and Data Validation Reports, except for 2 cases: 1) MW-212A was mislabeled in Event 4 but corrected in database and Data Validation Report; and 2) MW-212A and MW 215A had been mislabeled in Event 12 COC, but later corrected, and were correct in lab report, Data Validation Report, and database.
	Contamination	Field blanks had no detections of Cobalt or Lithium.
	Sampling technique	Used hydrasleeves in MW-202B in Event 10. Upgradient wells MW-212B and MW-213B had insufficient water for sampling in all events.
	Turbidity	Turbidity after stabilization < 10 NTU in all wells, so not a concern.
	Sampling anomalies	No other anomalies noted in field records.
Laboratory Causes (ASD Type II)	Calibration	No comments on lab calibration in Data Validation Reports for Appendix IV parameters.
	Contamination	Lab blanks had no Cobalt or Lithium.
	Digestion methods	No differences for Appendix IV parameters.
	Dilution corrections	Dilution factors in some events different for Co and Li between wells in same event, but most values detected, so no errors in detection limits.
	Interference	No concerns mentioned in Data Validation Reports.
	Analytical methods	Methods same as CCR Groundwater Monitoring Plans for Co and Li.
	Laboratory technique / qualifier flags	Had low recoveries for MS/MSD for Co in Event 6 (MW-220A and field duplicate) and in Event 10 (MW-216A and field duplicate, MW-202B, and MW-203B). Had low recoveries for MS/MSD for Li in Event 6 (MW-220A). Qualifier flags used appropriately.
	Transcription error(s)	None identified.
Statistical Evaluation Causes (ASD Type III)	Lack of statistical independence	Sampling interval was monthly or longer in upgradient wells MW-212A and MW-215B and well diameters are small (2-inch), so not likely to be a concern.
	Outliers	None identified in wells used for Assessment Monitoring.
	False positives	In 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	In upgradient wells MW-212A and MW-215B, had all but 1 non-detect values for Co. Both wells had all detected values for Li. Co and Li detected in 5 wells used for Assessment Monitoring (MW-216A, MW-220A, MW-202B, MW-203B, MW-204B).
	Background data / change in normality	No new background data used for Assessment Monitoring (Events 11,12, and 13 [AM-1, -2, and -3, respectively]).

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	Mine Spoil: Boron SSIs in MW-216A and -220A, and -24; Sulfate SSI in MW-216A. Uniontown Sandstone: Boron and Sulfate SSIs in MW-202B, -203B, and -204B.
1b	If the CCR unit contains FGD gypsum (only) is there an SSI/SSL for sulfate?	Yes	CCR Release	Key	Monitoring Point	FGD gypsum has only been co-disposed with fly ash in the Phase 3 landfill area. Mine Spoil: Sulfate SSI in MW-216A. Uniontown Sandstone: Sulfate SSIs in MW-202B, -203B, and -204B.
1c	Are there other constituents in the groundwater that represent primary indicators? List the applicable constituents.	Yes	CCR Release	Supporting	Monitoring Point	Mine Spoil: Calcium and Chloride are found at detectible levels in multiple downgradient monitoring wells; Lithium is an SSL for downgradient wells MW-216A and MW-220A Uniontown Sandstone: Calcium is found at detectible levels in multiple downgradient monitoring wells; Lithium is an SSL for downgradient wells MW-202B and MW-204B.
1d	Is there an SSI/SSL for any of the other primary indicators?	Yes	CCR Release	Key if No	Monitoring Point	Mine Spoil: Calcium (MW-216A and -220A) and Chloride (MW-216A and -220A) have exhibited SSIs. Lithium (MW-216A and MW-220A) has exhibited SSLs during 2018 assessment monitoring. Uniontown Sandstone: Calcium (MW-202B, -203B, and -204B) has exhibited SSIs. Lithium (MW-202B and -204B) has exhibited SSLs during 2018 assessment monitoring.
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	Mine Spoil: Calcium, Chloride, and Sulfate – Yes; Boron is indeterminate as it is not analyzed as part of the site's leachate sampling and analysis program. It is noted that statistical analysis has not been performed on leachate results -- evaluation based on the November 2017 leachate sampling event; Lithium – Yes. Uniontown Sandstone: Calcium and Sulfate – Yes; Boron is indeterminate as it is not analyzed as part of the site's leachate sampling and analysis program. It is noted that statistical analysis has not been performed on leachate results; evaluation based on the November 2017 leachate sampling event; Lithium – Yes.
1f	Are concentrations for the primary indicators increasing?	No	Uncertain	Supporting	Monitoring Point	Mine Spoil: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 years) for trend analysis. Uniontown Sandstone: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 years) 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	Mine Spoil: SSIs for pH (MW-216A and -220A) and TDS (MW-216A). Arsenic (MW-216A and -220A): SSLs for Cobalt (MW-216A and -220A) identified during AM events conducted in 2018

	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.)					Uniontown Sandstone: SSIs for pH (MW-202B, -203B, and -204B) and TDS (MW-202B and -204B). Radium 226+228 (MW-202B) has exhibited elevated downgradient concentrations as compared to upgradient concentrations.
2b	Are the constituents identified in 2a present in leachate in concentrations statistically higher than background?	Yes / No	Uncertain	Key if No	Constituent	Mine Spoil: pH (below Lower Prediction Limit) and TDS – Yes. Arsenic and Cobalt – No. Uniontown Sandstone: pH (below Lower Prediction Limit) and TDS – Yes. Radium 226+228 is indeterminate as it's not analyzed as part of the site's leachate sampling and analysis program. It is noted that statistical analysis has not been performed on leachate results; evaluation based on the November 2017 leachate sampling event.
2c	Are concentrations for any of the secondary indicators increasing? List the applicable constituents.	No	Uncertain	Supporting	Monitoring Point	Mine Spoil: No. It should be noted that the CCR dataset covers a very limited time range (~1.5 years) for trend analysis. Uniontown Sandstone: 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?	Yes	CCR Release	Key	Monitoring Point	Major ion chemistry analysis completed as Stiff diagrams indicate downgradient well chemistry similar to that of leachate.
3c	Does major ion chemistry suggest a mixture of leachate and background groundwater?	Yes	CCR Release			Major ion chemistry analysis completed as Stiff diagrams suggest a mixture of leachate and background groundwater.
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 1980'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 Cobalt and Lithium SSLs were identified in the downgradient wells, all of which are positioned downgradient of the landfill 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	**Mine Spoil** Boron - CCR Leachate Release (Row a) Calcium - CCR Leachate Release (Row a) Chloride - CCR Leachate Release (Row a) Cobalt – Possible CCR Leachate Release + Possible Alternative Source (row a) Lithium - CCR Leachate Release (Row a) pH – CCR Leachate Release (Row a) Sulfate – CCR Leachate Release (Row c) TDS - CCR Leachate Release (Row c) **Uniontown Sandstone** Boron - Indeterminate Calcium - CCR Leachate Release + Possible Alternative Source (Row c) Lithium - CCR Leachate Release (Row b) pH – CCR Leachate Release (Row a) Sulfate - CCR Leachate Release + Possible Alternative Source (Row b) TDS - CCR Leachate Release + Possible Alternative Source (Row b)
4c	Is the CCR unit immediately underlain by clay, shale, or other geologic media with low hydraulic conductivity?	No	CCR Release	Supporting	Unit	Almost the entire landfill footprint (Phases 1, 2, and 3) sits atop coal strip mine backfill materials that have mid-range hydraulic conductivities.
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.
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?	Yes	CCR Release	Supporting	Monitoring Point	The CCR Rule-defined uppermost aquifer at the site is comprised of two water-bearing strata that are hydraulically connected. Both of the site's upgradient wells (MW-212A and MW-215B) are located along the appropriate groundwater flow paths to their corresponding downgradient wells.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
CCR Unit Design						
5a	Does the entire footprint of the monitored CCR unit have a liner?	No / Yes	CCR Release / Potential Alternate Source	Supporting	Unit	The Phase 1 and 2 disposal areas are unlined while the Phase 3 disposal area (currently developed through Steps 1, 2, and 3-1) is double-lined.
5b	If the facility is lined, is it a composite liner?	Yes	Potential Alternate Source	Supporting	Unit	The Phase 3 disposal area is double-lined and utilizes a composite secondary 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?	No / Yes	CCR Release / Potential Alternate Source	Supporting	Unit	The Phase 1 and 2 disposal areas do have a bottom ash blanket underdrain while the Phase 3 disposal area (currently developed through Steps 1, 2, and 3-1) has both a leachate collection system and a leak detection 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	The unlined Phase 1 and 2 disposal areas are situated within tributary ravines and the CCR Rule-defined uppermost aquifer at the site is comprised of two water-bearing strata that are hydraulically connected. The higher water-bearing stratum outcropped within the ravines before the disposal site was developed so it is very likely that groundwater intersects some Phase 1 and 2 CCRs.

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	Monitoring Point	Historical surface mining and reclamation activities have the potential to cause metals and other contaminants to leach to groundwater. Historical maintenance activities near the LSI have the potential to act as a source of CCR-related contaminants in addition to non-CCR related contaminants. These potential alternative sources were assessed during this Appendix IV ASD.
6b	Are any current or former potential alternative sources background of the monitoring location?	Yes	Potential Alternate Source	Supporting	Monitoring Point	Mine spoil was placed in upgradient (background) areas of the site. Based on groundwater flow mapping, the former maintenance building near the LSI is upgradient (background) of wells exhibiting SSLs for cobalt (MW-216A and -220A).
6c	Do monitoring locations between a potential background source and CCR unit have concentrations at SSI/SSL levels?	Yes/No	Potential Alternate Source	Supporting	Constituent	Lithium – Side- to mid-gradient wells MW-214A/B, MW-210A contain concentrations of lithium above the GWPS in the mine spoil/weathered bedrock aquifer and the Uniontown Sandstone aquifer. Mid-gradient piezometer PZ-2 contains concentrations of lithium below the GWPS in the mine spoil/weathered bedrock aquifer. Cobalt – There are no monitoring locations between the potential background source and CCR unit that have concentrations that constitute an SSI and/or SSL.
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 background from the facility?	Yes	Potential Alternate Source	Supporting	Unit	The entire area underlying the CCR unit waste boundary and upgradient areas have been historically surface mined for the Waynesburg Coal. Mine spoil and fly ash were used to reclaim the surface-mined areas.
7c	Does the site have other CCR units that are background 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)?	Yes	Potential Alternate Source	Supporting	Unit	The Phase 1 and 2 disposal areas are unlined while the Phase 3 disposal area (currently developed through Steps 1, 2, and 3-1) is double-lined.

	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	Potential Alternate Source	Supporting	Unit	The Phase 1 and 2 disposal areas do have a bottom ash blanket underdrain while the Phase 3 disposal area (currently developed through Steps 1, 2, and 3-1) has both a leachate collection system and a leak detection system.
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 liner system 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	Historical and any current dust control is performed using river water (direct withdrawal).
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?	Yes	Potential Alternate Source	Supporting	Monitoring Point	MW-216A and MW-220A are located downgradient of a former haul road and maintenance area.
7i	Is the monitoring point downgradient of or near sluice water lines, handling equipment, or storage areas?	Yes	Potential Alternate Source	Supporting	Monitoring Point	MW-216A and MW-220A are located downgradient of former maintenance building.
7j	Is the monitoring point downgradient of or close to a leachate collection pipeline or leachate storage structure?	Yes	Potential Alternate Source	Supporting	Monitoring Point	MW-216A and MW-220A are located close to the LSI.
7k	Have there been any documented spills of CCR or leachate or sluice water in background or nearby locations?	No	No Alternate Source	Supporting	Monitoring Point	There are no documented spills of CCR or 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 background or nearby areas?	No	No Alternate Source	Supporting	Monitoring Point	CCRs have historically been dry disposed at the site in both lined and unlined areas with appropriate run-off and leachate control measures (refer to LOEs 5a through 5c).
7m	Is there any history of on-site or background oil or chemical spills or leaking underground storage tanks?	No	No Alternate Source	Supporting	Monitoring Point	No history of on-site or upgradient oil or chemical spills or use of underground storage tanks.
7n	Does a significant amount of road salting occur on-site? (also see 9b)	No	No Alternate Source	Supporting	Monitoring Point	Road salting has historically not been performed at the site.
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	Fly ash was commingled with mine spoil during surface mine reclamation activities across the site.
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 of, and not near the CCR unit.
Natural Variation						
8a	Are background wells screened in the same geomedia as the monitoring point?	Yes	No Alternate Source	Supporting	Monitoring Point	The CCR Rule-defined uppermost aquifer at the site is comprised of two water-bearing strata that are hydraulically connected. Both of the site's upgradient wells (MW-212A and MW-215B) are located along the appropriate groundwater flow paths to their corresponding downgradient wells.
8b	Is the aquifer comprised of poorly buffered media such as sand and gravel?	No	No Alternate Source	Supporting	Unit	The aquifers are comprised of mine spoil/weathered bedrock and Uniontown Sandstone which is not considered to be a poorly buffered media.

	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)						
8c	Is the pH at the monitoring point similar to the background pH?	No	Potential Alternate Source	Supporting	Monitoring Point	Mine Spoil: pH of upgradient background well MW-212A is 7.54, while downgradient wells MW-216A and MW-220A are 5.70 and 5.96, respectively. Uniontown Sandstone: pH of upgradient background well MW-215B is 7.69, while downgradient wells MW-202B and MW-204B are 6.54, and 6.55, respectively.
8d	Is the monitoring point near a river?	No	No Alternate Source	Supporting	Monitoring Point	None of the monitoring points are located near a river.
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	Cobalt: Cobalt is reactive and occurs in combination with arsenic and sulfur; it may be sorbed to mineral oxides. Lithium: Lithium is non-reactive.
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 or drought conditions.
8h	Does the aquifer contain saline water at depth?	No	No Alternate Source	Supporting	Unit	Saline conditions are not observed in 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 east for both aquifers monitored.

	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						
9a	Are there former coal mines, mine spoil, or conveyers near the CCR unit or background from the facility (also consider under "On-site")?	Yes	Potential Alternate Source	Supporting	Unit	Refer to LOE 7b.
9b	Does a significant amount of road salting occur off-site?	N/A	N/A	Supporting	Unit	The site, including the uppermost aquifer, is situated in elevation above all surrounding off-site roadways on which road salting may occur.
9c	Does the surrounding land use include agriculture (crops)?	Yes	No Alternate Source	Supporting	Unit	The neighboring properties appear to have 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 Alternate Source	Supporting	Unit	The neighboring properties appear to have agricultural uses (animal) which are determined to present little to no impacts to groundwater as it relates to the CCR unit.
9e	Are there current or former underground or aboveground storage tanks that have had a release? (Consider gas stations and surrounding industrial activities.)	No	No Alternate Source	Supporting	Unit	There are no known uses of underground or above ground storage tanks near the CCR unit.
9f	Are there, or were there, oil and gas production wells in the vicinity of the site?	ND	ND	Supporting	Unit	Due to the nature of the SSIs and SSLs, nearby oil and gas production was not assessed as part of this Appendix IV ASD.
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	There are no known off-site industrial or commercial sources that could potentially impact the uppermost aquifer being monitored for the CCR unit.
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 surface mining and filling operations could have introduced minerals to infiltrating groundwater and oxygen allowing constituents of concern to become mobile in groundwater.

	Line of Evidence (LOE)	Determination[1] (Yes, No, ND, N/A)	Indication	LOE Type[2]	Applies to[3]	Weight of Evidence Determination / Basis
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 1970s, there has been enough time for potentially affected 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 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 4 - Nature and Extent of Release Sampling
Cobalt and Lithium Data**

Monitoring Well ID	Cobalt (mg/L)		Lithium (mg/L)	
	N&E Event 1	N&E Event 2	N&E Event 1	N&E Event 2
MW-202B	0.009096	0.007678	0.135213	0.143547
MW-203B	0.00076	0.000619	0.025202	0.026791
MW-204B	0.001178	0.000978	0.107249	0.120743
MW-210A	0.005487	0.005528	0.193175	0.19922
MW-210B	<MDL	<MDL	0.063195	0.066396
MW-212A	<MDL	<MDL	0.056653	0.064589
MW-213A	<MDL	<MDL	0.027986	0.030394
MW-214A	0.001414	0.001204	0.138755	0.157622
MW-214B	<MDL	<MDL	0.093685	0.107054
MW-215A	0.000723	0.000864	0.132562	0.12345
MW-215B	<MDL	<MDL	0.082568	0.075974
MW-216A	0.425518	0.440698	0.127852	0.13459
MW-217A	0.001188	0.001933	0.192143	0.196715
MW-218A	0.001265	0.001541	0.322076	0.322557
MW-220A	0.136059	0.13415	0.079581	0.091538
MW-222A	0.168859	0.192676	0.031083	0.031518
MW-223A	0.29123	0.268367	0.070328	0.076467
MW-224A	0.025906	0.019371	0.013596	0.016032
PZ-2	0.394111	0.415425	0.02059	0.021313
PZ-5	0.02212	0.030202	0.051276	0.073825

Notes:
1. N&E Sampling Event 1 performed in June 2019.
2. N&E Sampling Event 2 performed in July 2019.

Table 5 - Leachate Data Summary

	Leachate Concentrations (mg/L)					GW Concentrations (mg/L) Mine Spoil / Weathered Bedrock							
Parameters	**DP1WD**	**DP2WD**	**LCSC1**	**LCSC2**	**LCSC Avg.**	**UG UPL (MW-212A)**	**MW-216A**	**MW-220A**	**DG Avg.**	**LCSC Avg. > UG UPL?**	**DG Avg. > UG UPL?**	**MW-216A < LCSC Avg.?**	**MW-220A < LCSC Avg.?**
Cobalt	Not Relevant for Mine Spoil Aquifer Monitoring Wells		0.004152	0.008796	0.007248	0.00849	0.440698	0.13415	0.28742	No	Yes	No	No
Lithium			3.06713	1.282585	2.174858	0.08305	0.13459	0.091538	0.11306	Yes	Yes	Yes	Yes

	Leachate Concentrations (mg/L)					GW Concentrations (mg/L) Uniontown Sandstone									
Parameters	**DP1WD**	**DP2WD**	**LCSC1**	**LCSC2**	**DPWD/ LCSC Avg.**	**UG UPL (MW-215B)**	**MW-202B**	**MW-203B**	**MW-204B**	**DG Avg.**	**DPWD/ LCSC Avg. > UG UPL?**	**DG Avg. > UG UPL?**	**MW-202B < DPWD/ LCSC Avg.?**	**MW-203B < DPWD/ LCSC Avg.?**	**MW-204B < DPWD/ LCSC Avg.?**
Lithium	0.2298245	0.9280485	3.06713	1.282585	1.376897	0.07311	0.143547	0.026791	0.120743	0.09703	Yes	Yes	Yes	Yes	Yes

Notes: DG -Downgradient; GW - Groundwater; UG - Upgradient; UPL - Upper Prediction Limit
Leachate Concentrations are averages of sampling performed in June and July 2019.
GW Concentrations of Cobalt and Lithium from sampling and analysis completed in July 2019.
UG UPL's based on 8 baseline sampling events.

DP1WD - Phase 1 Blanket Underdrain
DP2WD - Phase 2 Blanket Underdrain
LCSC1 - Phase 3, Step 1 and 3-1 LCS
LCSC2 - Phase 3, Step 2 and 3-1 LCS

FIGURES

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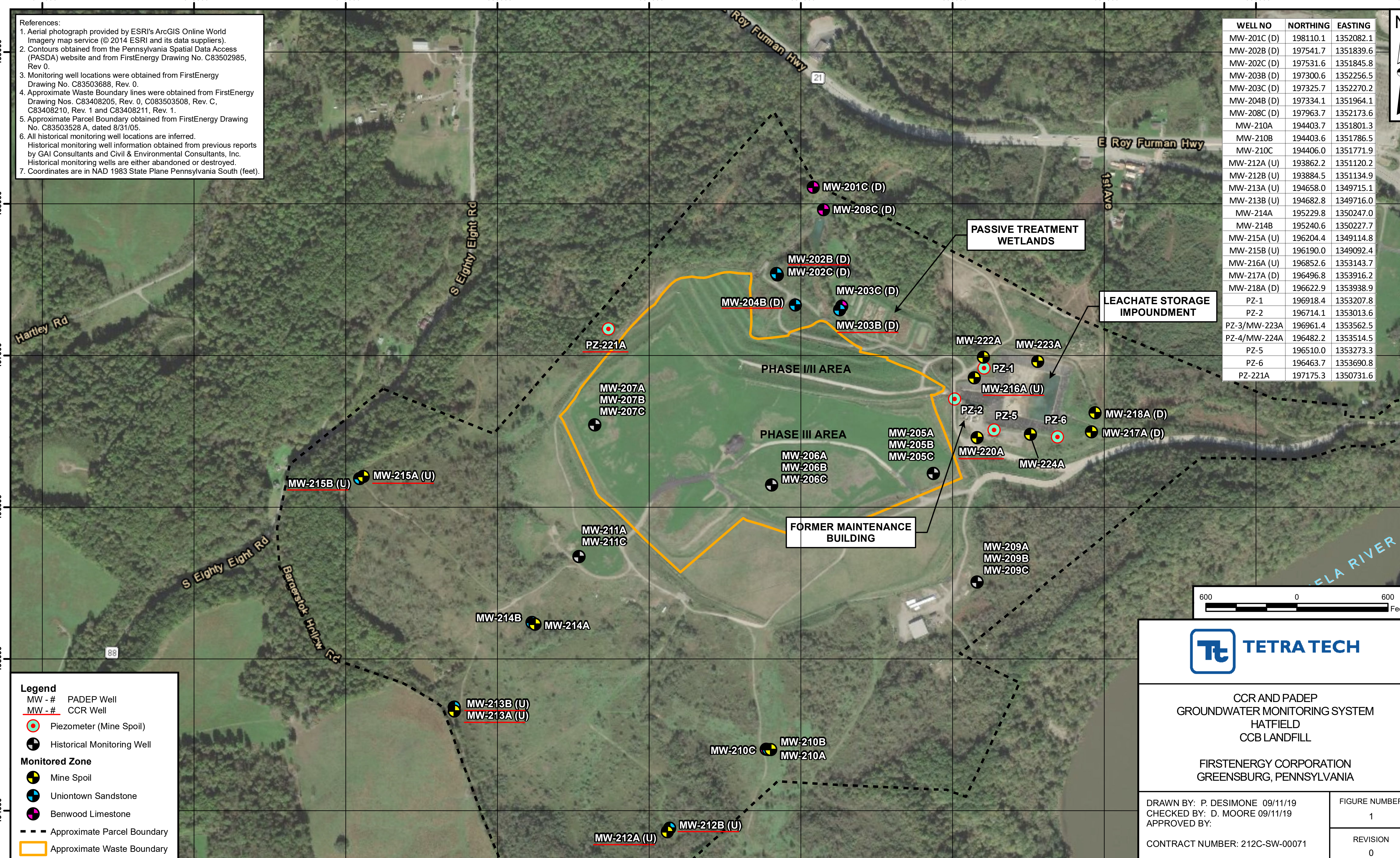

References:
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5. Approximate Parcel Boundary obtained from FirstEnergy Drawing No. C83503528 A, dated 8/31/05.
6. All historical monitoring well locations are inferred. Historical monitoring well information obtained from previous reports by GAI Consultants and Civil & Environmental Consultants, Inc. Historical monitoring wells are either abandoned or destroyed.
7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

WELL NO	NORTHING	EASTING
MW-201C (D)	198110.1	1352082.1
MW-202B (D)	197541.7	1351839.6
MW-202C (D)	197531.6	1351845.8
MW-203B (D)	197300.6	1352256.5
MW-203C (D)	197325.7	1352270.2
MW-204B (D)	197334.1	1351964.1
MW-208C (D)	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A (U)	193862.2	1351120.2
MW-212B (U)	193884.5	1351134.9
MW-213A (U)	194658.0	1349715.1
MW-213B (U)	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A (U)	196204.4	1349114.8
MW-215B (U)	196190.0	1349092.4
MW-216A (U)	196852.6	1353143.7
MW-217A (D)	196496.8	1353916.2
MW-218A (D)	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend
MW - # PADEP Well
MW - # CCR Well
Piezometer (Mine Spoil)
Historical Monitoring Well

Monitored Zone
Mine Spoil
Uniontown Sandstone
Benwood Limestone
Approximate Parcel Boundary
Approximate Waste Boundary

TETRA TECH

CCR AND PADEP
GROUNDWATER MONITORING SYSTEM
HATFIELD
CCB LANDFILL

FIRSTENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 09/11/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER
1

REVISION
0

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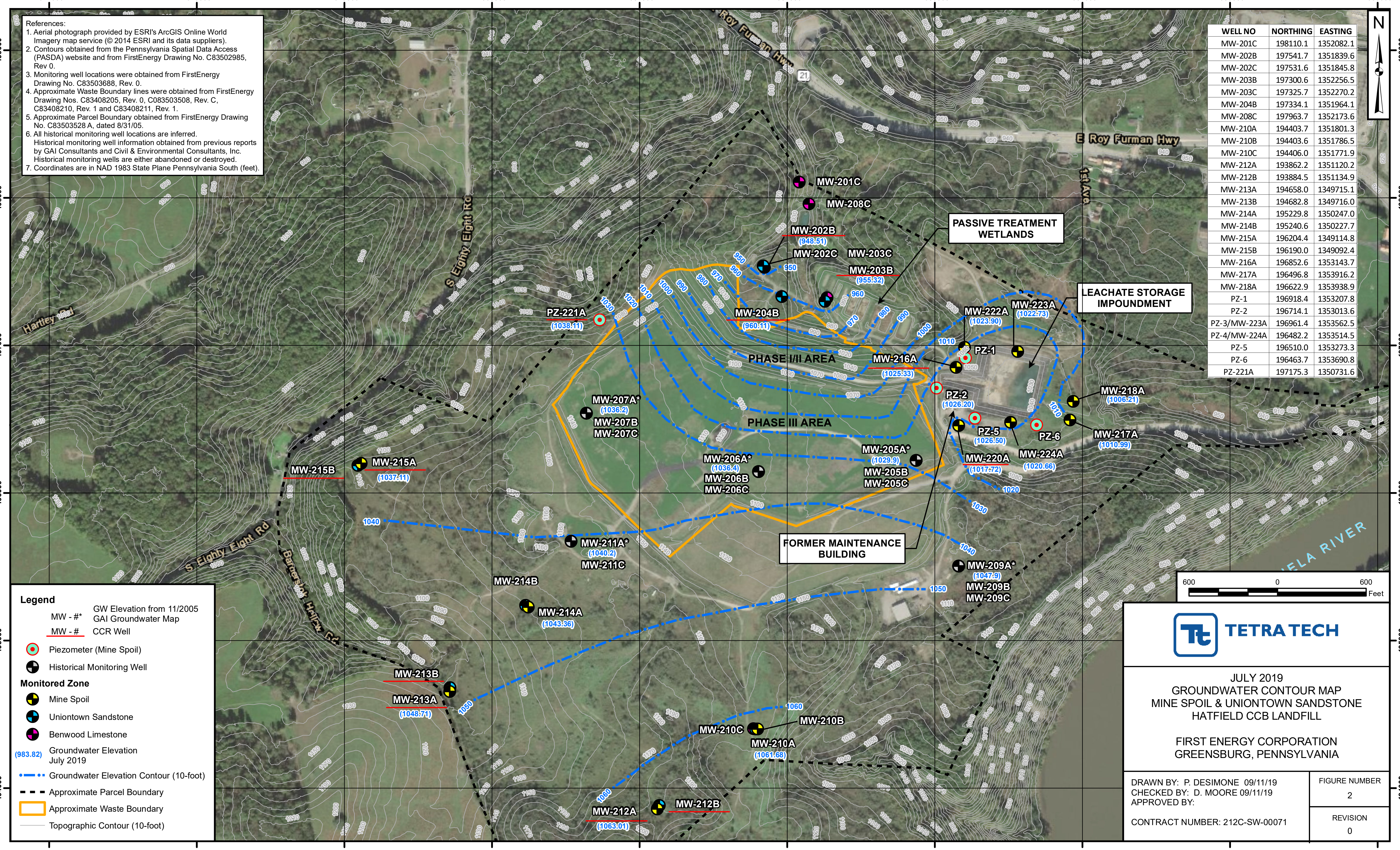

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7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

WELL NO	NORTHING	EASTING
MW-201C	198110.1	1352082.1
MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
MW-212A	193862.2	1351120.2
MW-212B	193884.5	1351134.9
MW-213A	194658.0	1349715.1
MW-213B	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

- MW - #* — GW Elevation from 11/2005 GAI Groundwater Map
- MW - # — CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Zone

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- (983.82) — Groundwater Elevation July 2019
- Groundwater Elevation Contour (10-foot)
- Approximate Parcel Boundary
- Approximate Waste Boundary
- Topographic Contour (10-foot)

TETRA TECH

JULY 2019
GROUNDWATER CONTOUR MAP
MINE SPOIL & UNIONTOWN SANDSTONE
HATFIELD CCB LANDFILL

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 09/11/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER
2

REVISION
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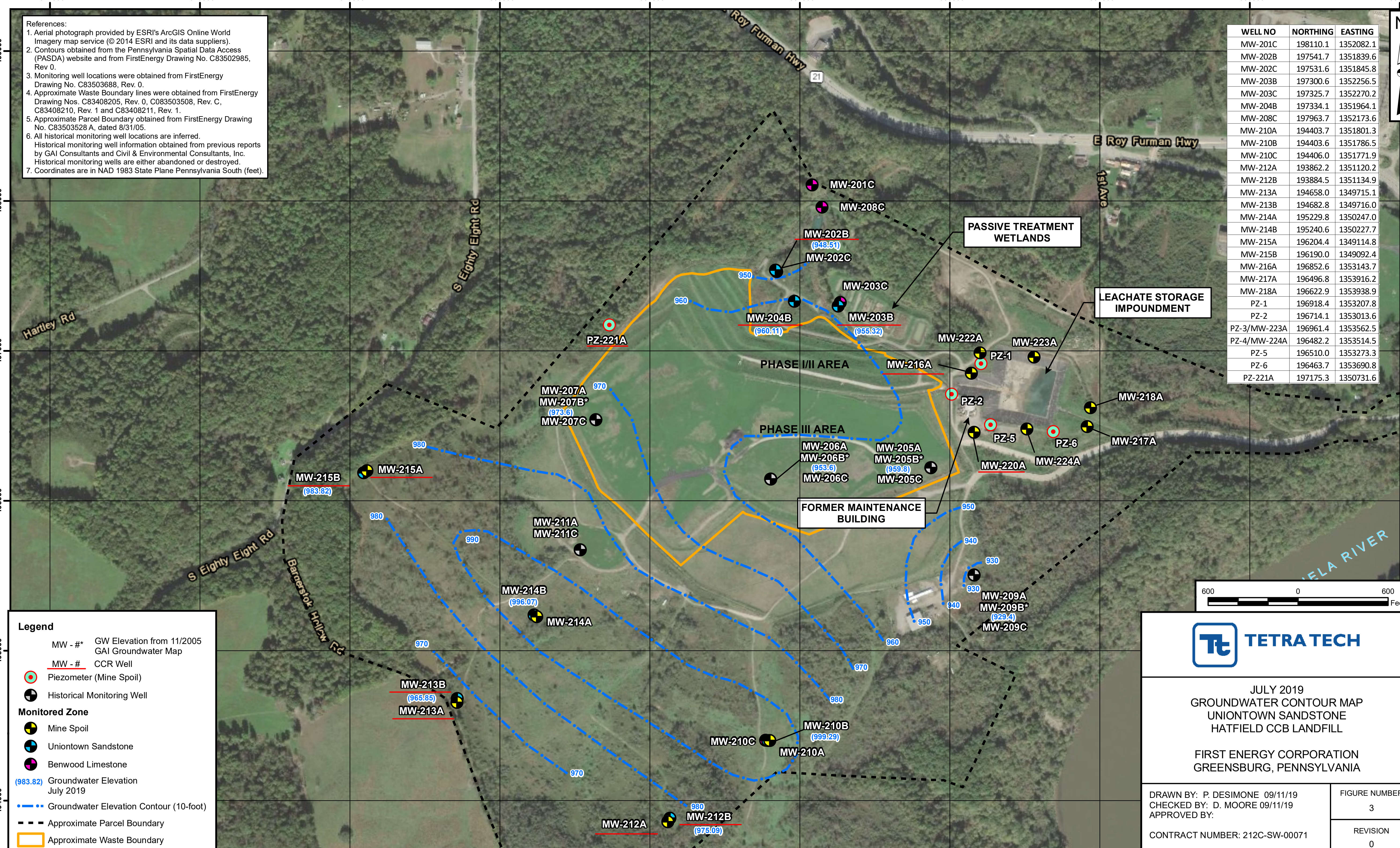

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WELL NO	NORTHING	EASTING
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MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
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MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

- MW - #* GW Elevation from 11/2005 GAI Groundwater Map
- MW - # CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Zone

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- (983.82) Groundwater Elevation July 2019
- Groundwater Elevation Contour (10-foot)
- Approximate Parcel Boundary
- Approximate Waste Boundary

TETRA TECH

JULY 2019
GROUNDWATER CONTOUR MAP
UNIONTOWN SANDSTONE
HATFIELD CCB LANDFILL

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 09/11/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 3

REVISION 0

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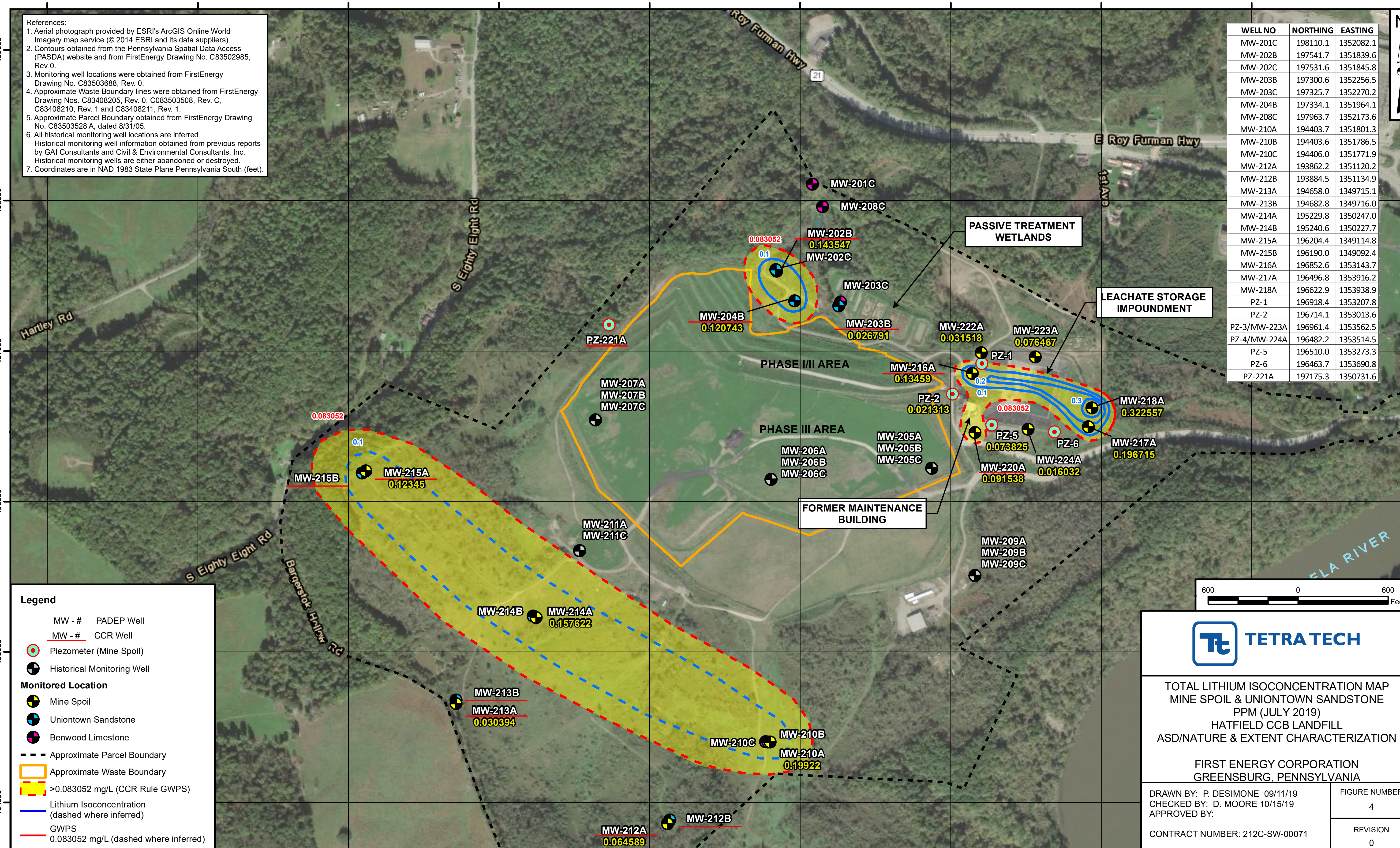

References:
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7. Coordinates are in NAD 1983 State Plane Pennsylvania South (feet).

WELL NO	NORTHING	EASTING
MW-201C	198110.1	1352082.1
MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
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MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

- MW - # PADEP Well
- MW - # CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Location

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- Approximate Parcel Boundary
- Approximate Waste Boundary
- >0.083052 mg/L (CCR Rule GWPS)
- Lithium Isoconcentration (dashed where inferred)
- GWPS 0.083052 mg/L (dashed where inferred)

TETRA TECH

TOTAL LITHIUM ISOCONCENTRATION MAP
MINE SPOIL & UNIONTOWN SANDSTONE
PPM (JULY 2019)
HATFIELD CCB LANDFILL
ASD/NATURE & EXTENT CHARACTERIZATION

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 10/15/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER 4

REVISION 0

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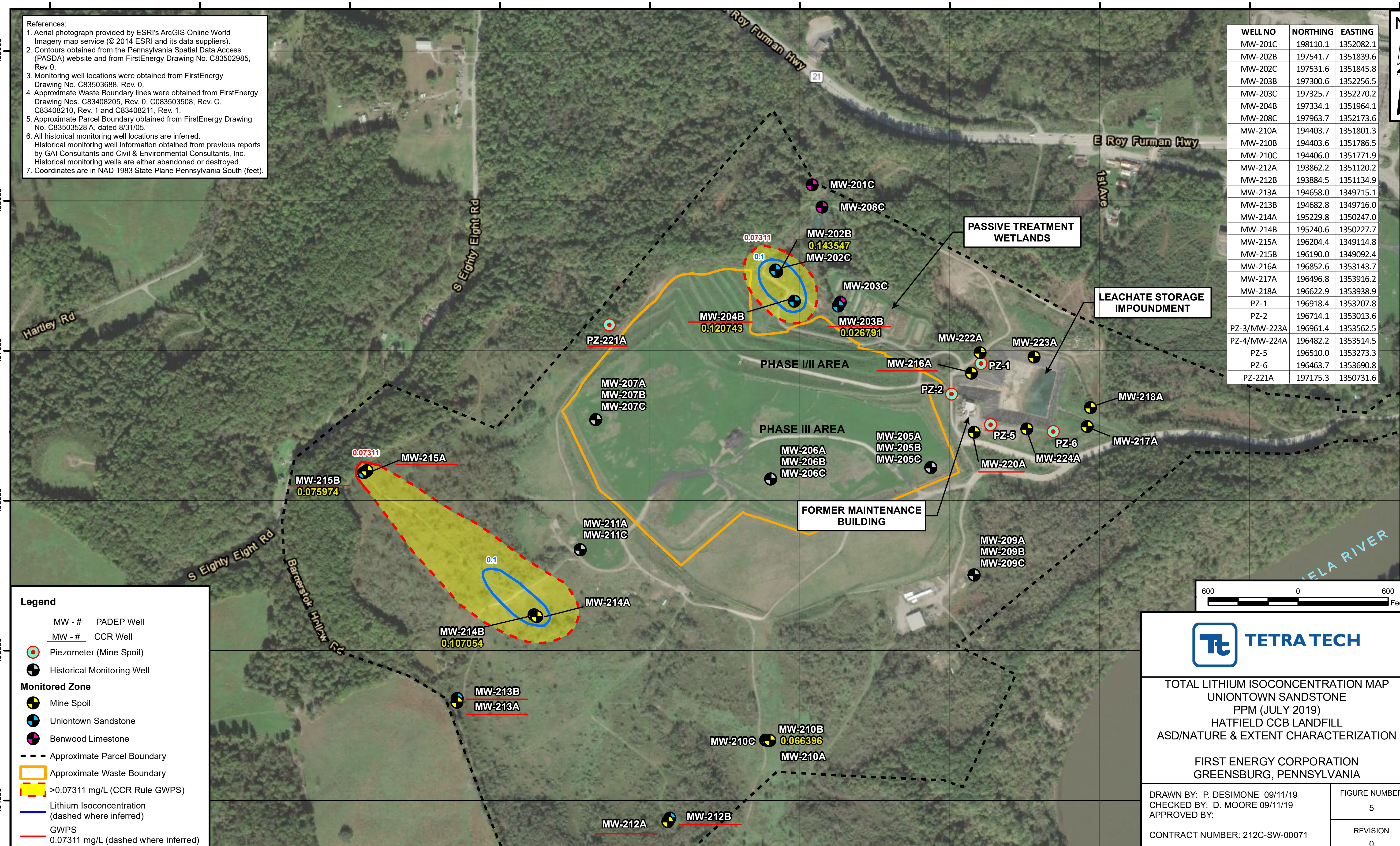

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MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
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MW-212B	193884.5	1351134.9
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MW-214A	195229.8	1350247.0
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MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

- MW - # PADEP Well
- MW - # CCR Well
- Piezometer (Mine Spoil)
- Historical Monitoring Well

Monitored Zone

- Mine Spoil
- Uniontown Sandstone
- Benwood Limestone
- Approximate Parcel Boundary
- Approximate Waste Boundary
- >0.07311 mg/L (CCR Rule GWPS)
- Lithium Isoconcentration (dashed where inferred)
- GWPS 0.07311 mg/L (dashed where inferred)

TETRA TECH

TOTAL LITHIUM ISOCONCENTRATION MAP
UNIONTOWN SANDSTONE
PPM (JULY 2019)
HATFIELD CCB LANDFILL
ASD/NATURE & EXTENT CHARACTERIZATION

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19 CHECKED BY: D. MOORE 09/11/19 APPROVED BY:	FIGURE NUMBER 5
CONTRACT NUMBER: 212C-SW-00071	REVISION 0

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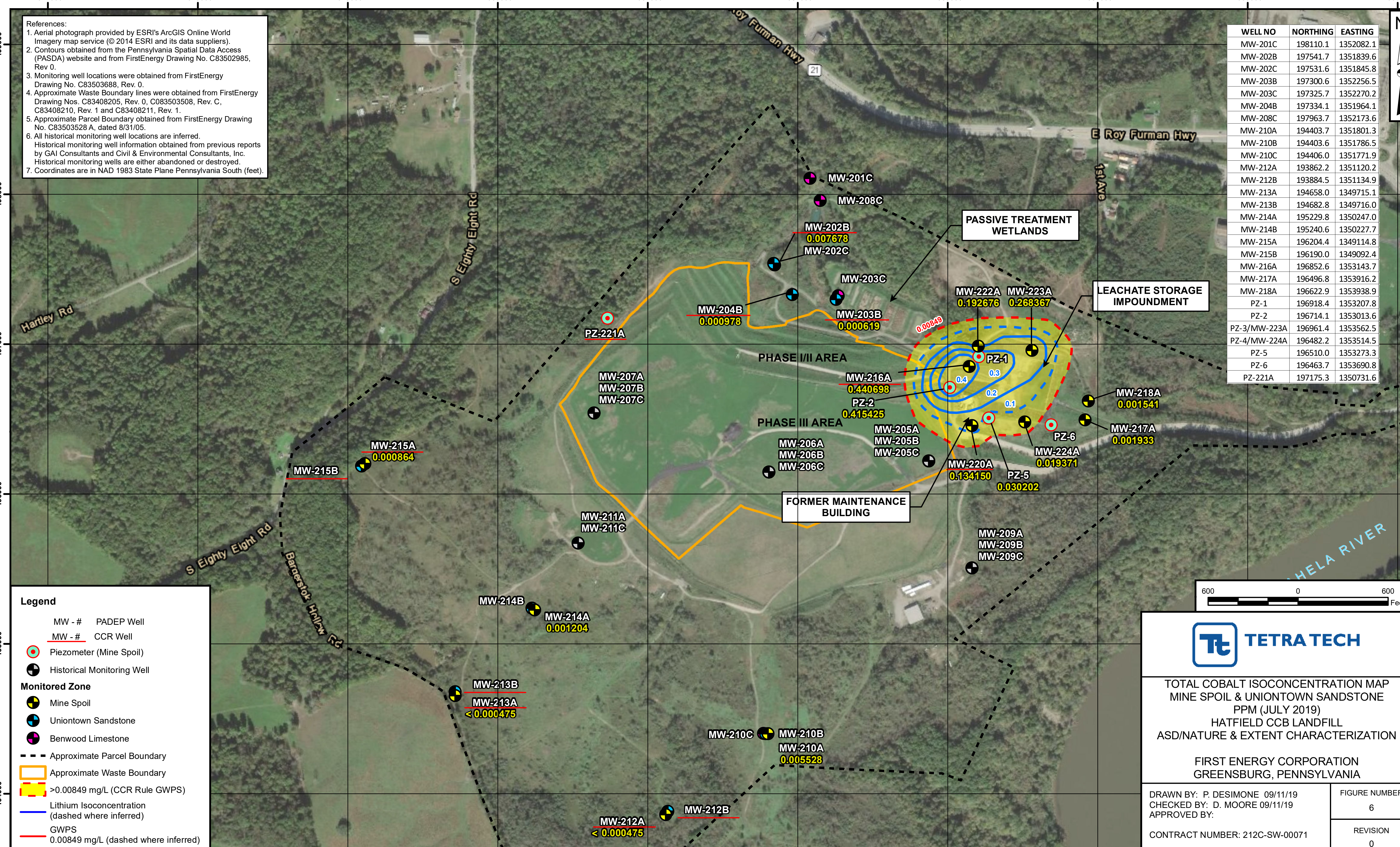

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WELL NO	NORTHING	EASTING
MW-201C	198110.1	1352082.1
MW-202B	197541.7	1351839.6
MW-202C	197531.6	1351845.8
MW-203B	197300.6	1352256.5
MW-203C	197325.7	1352270.2
MW-204B	197334.1	1351964.1
MW-208C	197963.7	1352173.6
MW-210A	194403.7	1351801.3
MW-210B	194403.6	1351786.5
MW-210C	194406.0	1351771.9
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MW-212B	193884.5	1351134.9
MW-213A	194658.0	1349715.1
MW-213B	194682.8	1349716.0
MW-214A	195229.8	1350247.0
MW-214B	195240.6	1350227.7
MW-215A	196204.4	1349114.8
MW-215B	196190.0	1349092.4
MW-216A	196852.6	1353143.7
MW-217A	196496.8	1353916.2
MW-218A	196622.9	1353938.9
PZ-1	196918.4	1353207.8
PZ-2	196714.1	1353013.6
PZ-3/MW-223A	196961.4	1353562.5
PZ-4/MW-224A	196482.2	1353514.5
PZ-5	196510.0	1353273.3
PZ-6	196463.7	1353690.8
PZ-221A	197175.3	1350731.6

Legend

MW - # PADEP Well
MW - # CCR Well
Piezometer (Mine Spoil)
Historical Monitoring Well

Monitored Zone

Mine Spoil
Uniontown Sandstone
Benwood Limestone
Approximate Parcel Boundary
Approximate Waste Boundary
>0.00849 mg/L (CCR Rule GWPS)
Lithium Isoconcentration (dashed where inferred)
GWPS 0.00849 mg/L (dashed where inferred)

TETRA TECH

TOTAL COBALT ISOCONCENTRATION MAP
MINE SPOIL & UNIONTOWN SANDSTONE
PPM (JULY 2019)
HATFIELD CCB LANDFILL
ASD/NATURE & EXTENT CHARACTERIZATION

FIRST ENERGY CORPORATION
GREENSBURG, PENNSYLVANIA

DRAWN BY: P. DESIMONE 09/11/19
CHECKED BY: D. MOORE 09/11/19
APPROVED BY:

CONTRACT NUMBER: 212C-SW-00071

FIGURE NUMBER
6

REVISION
0

APPENDIX B

Additional Monitoring Well Logs

2500-PM-LRWM0365 Rev. 2/96

Borehole Number: MW-210 (A, B, and C)
Surface Elevation (Ft/MSL): 1157.5 (ft)
Borehole Diameter: 5 3/4 inches, From 0 To 100.4'
3 inches, From 100.4 To 248.2'
Total Depth: 248.2 (ft)
Depth to Static Ground Water Level (SWL): A≃100 C≃231 B≃162 (ft)
Date SWL Measured: 3/01 (mm/dd/yy)

Drilling Method: 3 1/4" ID HOLLOW STEM AUGERS / NX CORING
Date Drilled: 01-30-01 to 02-05-01 (mm/dd/yy)
Drilled By: PENNSYLVANIA DRILLING CO.
Drillers License Number: 0406
Logged By: D.L. CREMEENS
County: GREENE
Township or Municipality: CUMBERLAND

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Rec**/Att	Comments	Well/Piezometer Construction	Depth (Ft)
0	CLAYEY SILT WITH ROCK FRAGMENTS			S-1	1.0/1.5	GRAY BROWN, STIFF, DRY. BLOW COUNTS = 1-5-8. MINE SPOIL	Note: Three monitoring wells (MW-210A, MW-210B, and MW-210C) were installed in seperate non-sampled boreholes. All borehole are located w/in ~30' of each other. See attached Figure MW-210A, MW-210B, and MW-210C for well construction details	
	BROKEN ROCK FRAGMENTS (MINE SPOIL)			S-2	0.5/1.5	GRAY, LOOSE, DRY. BLOW COUNTS = 9-12-14		
10				S-3	0.8/1.5	GRAY, LOOSE, DRY. BLOW COUNTS = 14-14-22		
	BROKEN BLACK SHALE AND COALY SHALE FRAGMENTS (MINE SPOIL)			S-4	0.7/1.5	BLACK, LOOSE, DRY. BLOW COUNTS = 3-6-6		
20				S-5	0.8/1.5	BLACK, LOOSE, DRY. BLOW COUNTS = 3-5-10		
	DECOMPOSED SILTY SHALE FRAGMENTS (MINE SPOIL)			S-6	0.7/1.5	BLACK AND GRAY, LOOSE, DRY. BLOW COUNTS = 4-17-10		
30	CLAYEY SILT AND SILTY CLAY; SOME SHALE AND BLACK SHALE FRAGMENTS (MINE SPOIL)			S-7	0.6/1.5	BROWNISH GRAY AND ORANGE, STIFF, DRY. BLOW COUNTS = 10-14-11		
				S-8	0.6/1.5	GRAY, STIFF, DRY. BLOW COUNTS = 6-8-10		
40				S-9	0.6/1.5	GRAY AND BROWN, STIFF, DRY. BLOW COUNTS = 4-11-14		
				S-10	1.1/1.5	GRAY AND BROWN, VERY STIFF, DRY. BLOW COUNTS = 10-17-23		
50				S-11	0.8/1.5	GRAY AND BROWN, STIFF, DRY. BLOW COUNTS = 4-10-14. AUGER REFUSAL AT 52'		
	DECOMPOSED SHALE BOULDER (MINE SPOIL)			S-12	0.8/1.5	BROWN AND GRAY, SOFT, DRY. BLOW COUNTS = 1-42-30		
60								

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

Recycled Paper

Borehole Number: MW-210 (A, B, and C)
Surface Elevation (Ft/MSL): 1157.5 (ft)
Borehole Diameter: 5¾ inches, From 0 To 100.4'
3 inches, From 100.4 To 248.2'
Total Depth: 248.2' (ft)
Depth to Static Ground Water Level (SWL): A≈100 (2003) B≈12 (ft)
Date SWL Measured: 3/01 (mm/dd/yy)

Drilling Method: 3¼" ID Hollow Stem Augers / NX Coring
Date Drilled: 01-30-01 to 02-05-01 (mm/dd/yy)
Drilled By: Pennsylvania Drilling Co.
Drillers License Number: 0406
Logged By: D.L. Cremeens
County: Greene
Township or Municipality: Cumberland

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Rec**/Att	Comments	Well/Piezometer Construction	Depth (Ft)
60	CLAYEY SILT AND ROCK FRAGMENTS (MINE SPOIL)			S-13	0.6/1.5	GRAY AND BROWN, STIFF, DRY; BLOW COUNTS = 2-8-9		
	FLY ASH			S-14	0.3/1.5	GRAY, SOFT, DRY; BLOW COUNTS = 0*-7-10 *-WEIGHT OF RODS & SPOON		
70				S-15	0.6/1.5	GRAY, SOFT, DRY; BLOW COUNTS = 2-7-7		
				S-16	0.4/1.5	GRAY, SOFT, DRY; BLOW COUNTS = 0*-0*-8 *-rods dropped		
80	CLAYEY SILT AND DECOMPOSED SHALE AND SANDSTONE FRAGMENTS (MINE SPOIL)			S-17	0.5/1.5	BROWNISH GRAY, SOFT, DRY; BLOW COUNTS = 5-15-15		
				S-18	0.6/1.5	DARK GRAY, STIFF, DRY; BLOW COUNTS = 5-14-19		
90				S-19	0.9/1.5	DARK GRAY, SOFT, DRY; BLOW COUNTS = 12-14-50/.4	89.89 SCREENED INTERVAL OF MONITORING WELL MW-210A	
				S-20	0.2/1.5	GRAY, LOOSE, DRY; BLOW COUNTS = 12-21-24		
100 / 100.4			3/01 MW-210A	S-21	0/0.4	NO RECOVERY; BLOW COUNTS = 50/.4		
	SANDSTONE BLOCKS, GRAY W/ORANGE STAINS, HARD			R-1	3.3/5.2	START CORING AT 100.4'; RQD = 40%		
105.6	TOP OF ROCK; DECOMPOSED SHALE AND COALY SHALE, BLACK, HARD			R-2	3.8/5.0	RQD = 16%	109.89	
110 / 112.6	SANDY SHALE GRADING TO SHALE, GRAY, HARD			R-3	4.6/5.0	RQD = 62%		
120								

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

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2500-PM-LRWM0365 Rev. 2/96

Borehole Number: MW-210 (A, B, and C)
Surface Elevation (Ft/MSL): 1157.5 (ft)
Borehole Diameter: 5¾ inches, From 0 To 100.4'
3 inches, From 100.4' To 248.2'
Total Depth: 248.2' (ft)
Depth to Static Ground Water Level (SWL): A≈100 C≈123 B≈162 (ft)
Date SWL Measured: 3/01 (mm/dd/yy)

Drilling Method: 3¼" ID HOLLOW STEM AUGERS / NX CORING
Date Drilled: 01-30-01 to 02-05-01 (mm/dd/yy)
Drilled By: PENNSYLVANIA DRILLING CO.
Drillers License Number: 0406
Logged By: D.L. CREMEENS
County: GREENE
Township or Municipality: CUMBERLAND

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Rec** / Att	Comments	Well/Piezometer Construction	Depth (Ft)
120	SHALE, GRAY, MEDIUM HARD			R-4	9.7 / 9.7	RQD = 47%		
123.2–124.0	COAL, BLACK, SOFT							
124.0–126.0	CLAYSTONE, GRAY, SOFT							
126.0–132.0	LIMY SHALE, GRAY, HARD			R-5	9.8 / 10.0	RQD = 80%		
130								
132.0	SANDSTONE GRADING TO SANDY SHALE, GRAY, HARD			R-6	9.3 / 9.3	RQD = 59%; OBLIQUE FRACTURES, CLEAN FACES AT 140' & 141'		
140								
145.0–146.0	SHALE, GRAY, HARD			R-7	1.4 / 1.5	RQD = 80%		
146.0–147.2	COALY SHALE, BLACK							
147.2–149.0	LIMY SHALE, DARK GRAY, VERY HARD							
149.0–154.2	LIMESTONE, GRAY, VERY HARD			R-8	9.7 / 10.0	RQD = 61%; OBLIQUE FRACTURES, CLEAN FACES AT 149', 153', 154'		
150								
154.2–155.8	LIMY SHALE, DARK GRAY, VERY HARD							
155.8–159.6	LIMESTONE, GRAY, VERY HARD			R-9	10.0 / 10.0	RQD = 86%; OBLIQUE FRACTURE CLEAN FACE AT 158'; 0.1' CLAY SEAM AT 160.0'	157.7	
159.6–163.6	LIMY SHALE, DARK GRAY, HARD		▼ 3/01 MW-210B				SCREENED INTERVAL OF MONITORING WELL MW-210B	
160								
163.6–166.1	SANDY SHALE, DARK GRAY, HARD							
166.1–178.0	SANDSTONE, GRAY, HARD			R-10	9.9 / 10.0	RQD = 89%; UNIONTOWN SANDSTONE		
170								
178.0	SANDY SHALE, MUDSTONE, GRAY, HARD			R-11	10.0 / 10.0	RQD = 73%; OBLIQUE FRACTURE, CLEAN FACE AT 178'	177.7	
180								

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

Borehole Number: MW-210 (A, B, and C)
Surface Elevation (Ft/MSL): 1157.5 (ft)
Borehole Diameter: 5 3/4 inches, From 0 To 100.4'
___ inches, From 100.4' To 248.2'
Total Depth: 248.2 (ft)
Depth to Static Ground Water Level (SWL): A=160 (C=225) B=162 (ft)
Date SWL Measured: 3/01 (mm/dd/yy)

Drilling Method: 3 1/4" ID HOLLOW STEM AUGERS / NX CORING
Date Drilled: 01-30-01 to 02-05-01 (mm/dd/yy)
Drilled By: PENNSYLVANIA DRILLING CO.
Drillers License Number: 0400
Logged By: D.L. CREMEENS
County: GREENE
Township or Municipality: CUMBERLAND

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Rec**/Att	Comments	Well/Piezometer Construction	Depth (Ft)
180–184.0	SANDY SHALE, MUDSTONE, GRAY, HARD			R-11	10.0/10.0	RQD = 73% OBLIQUE FRACTURE, CLEAN FACE AT 182'		
184.0–188.8	SANDY SHALE TO SHALE, GRAY, HARD			R-12	10.0/10.0	RQD = 88%		
188.8–189.7	COAL, BLACK, HARD					UNIONTOWN COAL		
189.7–192.2	SANDY SHALE WITH BLACK SHALE, HARD							
192.2–193.3	COAL, BLACK, HARD					UNIONTOWN COAL		
193.3–196.6	SHALE, DARK GRAY, HARD							
196.6–197.3	SANDSTONE, GRAY, HARD			R-13	9.0/10.0	RQD = 75%		
197.3–198.6	SHALE, DARK GRAY, HARD							
198.6–199.0	COAL, BLACK, SOFT					UNIONTOWN COAL		
199.0–200	BLACK SHALE, HARD							
200–201.7	LIMY SHALE, GRAY, VERY HARD							
202.5–205.8	LIMESTONE, GRAY, VERY HARD					OBLIQUE FRACTURE, CLEAN FACE AT 204'		
205.8–215.0	CLAYSTONE, GREENISH GRAY, MEDIUM HARD			R-14	9.7/10.0	RQD = 73% OBLIQUE AND HORIZONTAL FRACTURES W/SLICKENSIDES AT 209' & 214'		
215.0–221.0	FINE SANDSTONE, MUDSTONE, SANDY SHALE, DARK GRAY, HARD			R-15	9.9/10.0	RQD = 74% OBLIQUE FRACTURES, CLEAN FACES AT 219', 221', 222', 223', 225', & 227'	218.4 –	
221.0–227.0	SANDSTONE, MEDIUM GRAINED, CROSS BEDDED, GRAY, HARD						SCREENED INTERVAL OF MONITORING WELL MW-210C	
227.0–231.9	SANDY SHALE, DARK GRAY, HARD		▼ 3/01 MW-210C	R-16	10.0/10.0	RQD = 80% Note - unidentified natural gas from piezometer once installed - above LEL		
231.9–233.5	BLACK SHALE - COALY SHALE, BLACK, HARD							
233.5–	LIMESTONE					BENWOOD LIMESTONE		
240				R-17	10.0/10.0	RQD = 46% OBLIQUE FRACTURE, CLEAN FACE AT 237'	238.4 –	

* ▽ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

Use additional sheets with this format as necessary

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Borehole Number: MW-210 (A, B, and C)
Surface Elevation (Ft/MSL): 1157.5 (ft)
Borehole Diameter: 5 3/4 inches, From 0 To 100.4'
3 inches, From 100.4' To 248.2'
Total Depth: 248.2 (ft)
Depth to Static Ground Water Level (SWL): A≈100 B≈162 C≈231 (ft)
Date SWL Measured: 3/01 (mm/dd/yy)

Drilling Method: 3 1/4" ID HOLLOW STEM AUGERS / NX CORE
Date Drilled: 01-30-01 to 02-05-01 (mm/dd/yy)
Drilled By: PENNSYLVANIA DRILLING CO.
Drillers License Number: 0406
Logged By: D.L. CREMEENS
County: GREENE
Township or Municipality: CUMBERLAND

Depth (Ft)	Lithologic Description	Plot	Ground Water* Observations	Samples No.	Rec** / Att	Comments	Well/Piezometer Construction	Depth (Ft)
240 – 242.5	LIMESTONE, SHALY, GRAY, VERY HARD			R-17	10.0 / 10.0	RQD = 46% BENWOOD LIMESTONE		
242.5 – 248.2	CLAYSTONE, GREENISH GRAY, HARD			R-18	2.0 / 2.0	RQD = 100%		
248.2	BOTTOM OF CORE							
250								

* ∇ Encountered Ground Water ▼ Composite Static Water Level ** Recovered/Attempted

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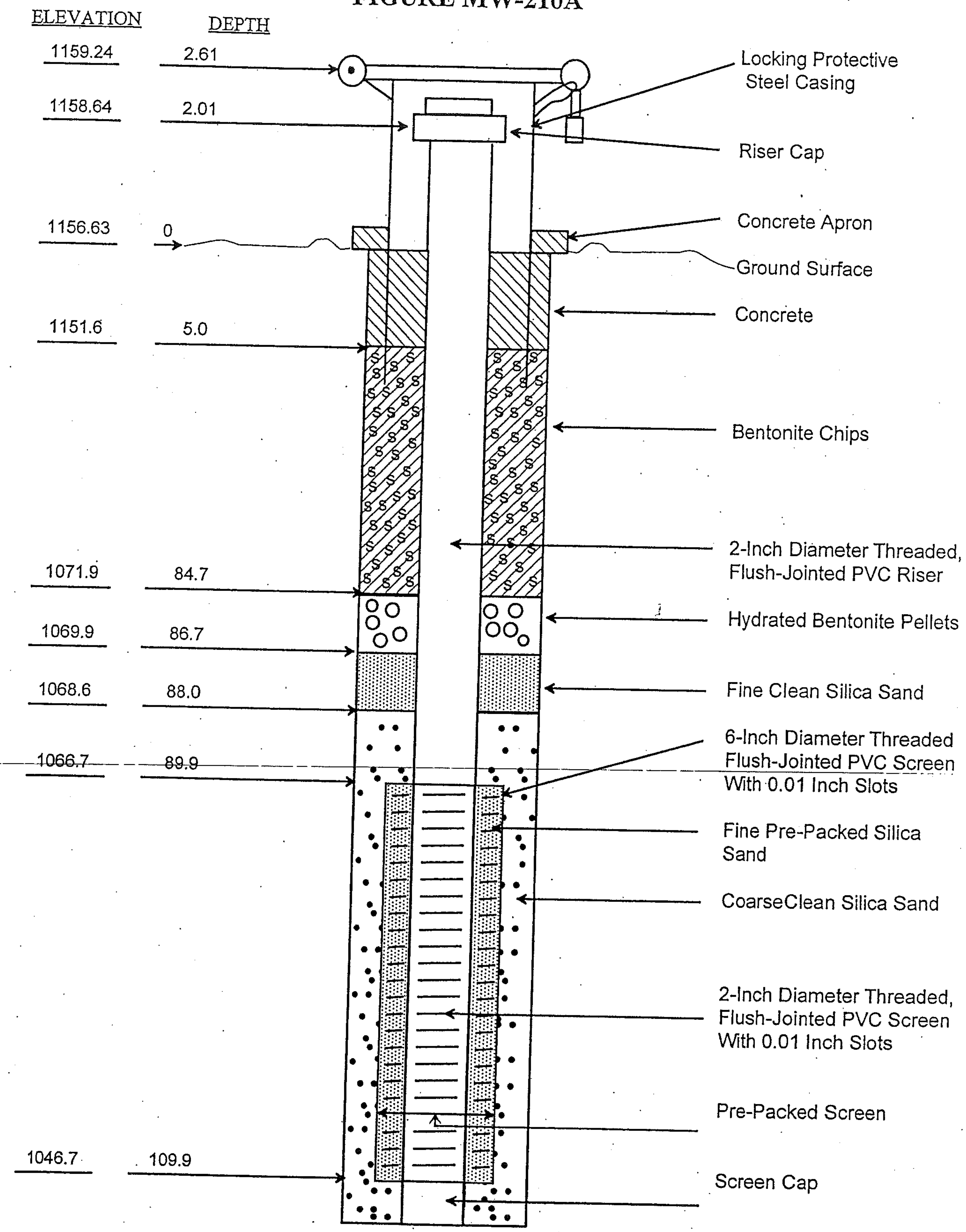
FIGURE MW-210A

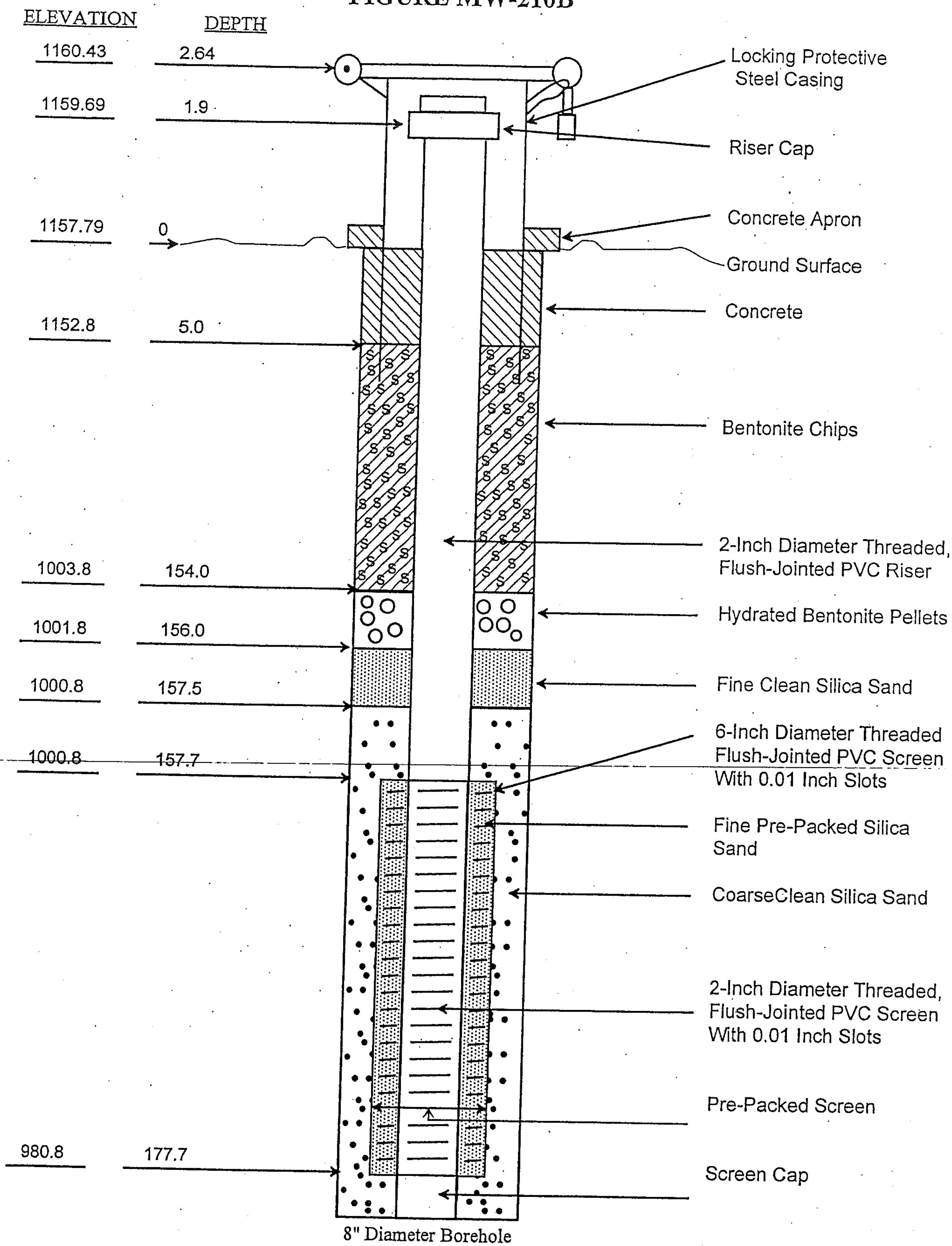


8" Diameter Borehole
(Not to Scale)

WELL AS-BUILT DIAMGRAM
HATFIELD FERRY POWER PLANT
ALLEGHENY ENERGY

Project 2000-287-12
D:wells/0028712

FIGURE MW-210B



(Not to Scale)

WELL AS-BUILT DIAMGRAM
HATFIELD FERRY POWER PLANT
ALLEGHENY ENERGY

Project 2000-287-12
D:wells/0028712

2540-PM-LRWM0365 Rev. 2/2001

Borehole Number: B-214 (MW-214(A) / MW-214(B))
Surface Elevation (Ft./MSL): 1140.8 (ft)
Borehole Diameter: ~8 inches, From 0.0' To 120.0'
~3 inches, From 120.0' To 200.0'
Total Depth: 200.0' (ft)
Depth to Static Groundwater Level (SWL): 119.0' (ft)
Date SWL Measured: 07/18/05 (mm/dd/yy)

Drilling Method: 4¼" I.D. Hollow Stem Augers / NQ2 Coring
Date Drilled: 07/12/05 - 07/15/05 (mm/dd/yy)
Drilled By: Pennsylvania Drilling Co.
Drillers License Number: 0406
Logged By: J.E. Bonetti / R.W. Fandray
County: Greene
Township or Municipality: Monongahela Twp.

Depth (Ft)	Lithologic Description	Plot	Groundwater * Observations	Samples No.	Rec** Att (Ft)	Comments (*** BC = Blow Count)	Well/Piezometer Construction	Depth (Ft)
1.0	Silty Clay (Mine Spoil)			S-1	1.4/1.4	Brown to Gray, Stiff to Dense, Moist; BC = 2-6-50/0.4	Note: Two (2) monitoring wells (MW-214(A) and MW-214(B)) installed in adjacent unsampled borings, well placement generally along contour interval approximately 20 feet from sampled boring B-214. See attached figures MW-214(A) and MW-214(B) for well construction details.	
5.0	Sandstone Boulders and Fragments (Mine Spoil)							
10	Silty Clay - Trace Sand and Sandstone Fragments to Boulders (Mine Spoil)			S-2	1.7/2.0	Stiff, Brown, Moist; BC = 2-6-7-4		10
15.0				S-3	0.8/2.0	Stiff, Brown, Moist; BC = 4-6-8-10		
20	Sandstone Boulder (Mine Spoil)			S-4	0.6/0.6	Very Dense, Gray, Dry; BC = 39-50/0.1		20
25.0	Fly Ash - Trace Sandstone Fragments (Fill)			S-5	2.0/2.0	Stiff, Gray, Dry; BC = 11-46-36-11		
30	Clay - Some Silt - Trace Gray Sandstone Fragments (Mine Spoil)			S-6	0.1/2.0	Stiff, Tan, Moist; BC = 14-4-4-4		30
33.0				S-7	0.0/2.0	No Recovery; BC = 10-14-12-8		
40	Sandstone Boulders and Fragments (Mine Spoil)			S-8	1.0/2.0	M. Dense, Gray, Dry; BC = 7-9-14-11		40
42.0	Void Space 40.0'-42.0'			S-9	0.0/2.0	No Recovery; BC = WOR/2.0'		
50	Sandstone Boulders and Fragments (Mine Spoil)			S-10	0.8/2.0	M. Dense, Gray, Dry; BC = 15-9-5-4		50
				S-11	1.3/2.0	M. Dense, Gray, Moist; BC = 48-14-14-33		
60				S-12	1.6/2.0	V. Dense, Gray, Moist; BC = 28-27-38-7		60
66.0				S-13	1.4/1.4	V. Dense, Gray, Dry; BC = 28-23-50/0.4		
69.0	Fly Ash (Fill)			S-14	0.8/2.0	V. Stiff, Gray, Moist; BC = 24-23-9-11		
70	(Next Sheet)							70

* ▽ Encountered Groundwater ▼ Composite Static Water Level **Recovered/Attempted

Use additional sheets with this format as necessary

2540-PM-LRWM0365 Rev. 2/2001

Borehole Number: B-214 (MW-214 (A) / MW-214 (B))
Surface Elevation (Ft./MSL): 1140.8 (ft)
Borehole Diameter: ~8 inches, From 0.0' To 120.0'
~3 inches, From 120.0' To 200.0'
Total Depth: 200.0' (ft)
Depth to Static Groundwater Level (SWL): 119.0' (ft)
Date SWL Measured: 07/18/05 (mm/dd/yy)

Drilling Method: 4¼" I.D. Hollow Stem Augers / NQ2 Coring
Date Drilled: 07/12/05 - 07/15/05 (mm/dd/yy)
Drilled By: Pennsylvania Drilling Co.
Drillers License Number: 0406
Logged By: J.E. Bonetti / R.W. Fandray
County: Greene
Township or Municipality: Monongahela Twp.

Depth (Ft)	Lithologic Description	Plot	Groundwater* Observations	Samples No.	Rec** / Att (Ft)	***BC = Blow Count Comments	Well/Piezometer Construction	Depth (Ft)
70	Sandstone Boulders and Fragments – Trace Shale Fragments and Silty Clay (Mine Spoil)			S-15	2.0/2.0	V. Dense, Gray, Moist; BC = 43-42-33-24		
				S-16	0.7/0.7	V. Dense, Gray, Dry; BC = 50-50/0.2		
80			▽ 84.0' (7/14/05 Pre-Core)	S-17	0.6/0.6	V. Dense, Gray, Dry; BC = 48-50/0.1		10
				S-18	2.0/2.0	Dense, Tan, Dry; BC = 9-19-16-28		
90				S-19	1.2/2.0	Dense, Gray, Dry; BC = 19-16-17-14		20
				S-20	0.0/2.0	No Recovery; BC = 17-12-15-33		
100 / 100.4	Silty Clay - Some Rock and Coal Fragments (Mine Spoil)			S-21	2.0/2.0	Stiff, Brown Gray, Moist; BC = 5-8-10-12	99.0' Screened Interval of Monitoring Well MW-214(A)	30
105.0	Sandstone Boulders and Fragments – Some Silty Clay (Mine Spoil)			S-22	1.3/1.3	V. Dense, Gray, Dry; BC = 12-36-50/0.3		
110	Trace Coal Fragments			S-23	0.8/1.4	V. Dense, Gray, Moist; BC = 10-12-50/0.4		40
	T.O.R. @ 120.0'		▽ 119.0' (7/18/05)	S-24	1.5/1.9	Dense, Gray Black, Moist; BC = 45-15-30-50/0.5	119.0'	
120	Decomposed Shale, Some Carbonaceous, Dark Gray, M. Soft			S-25	0.7/0.7	V. Dense, Gray, Dry; BC = 27-50/0.2		50
125.7				R-1	3.0/5.0	RQD = 0% Weathered Oblique Fracture (124.7'-125.0')		
126.8	Coal - Some Shale, Black, M. Hard							
129.2	Claystone (Silty to Sandy) Gray, Soft			R-2	5.0/5.0	RQD = 16% Claystone - Slickensided		
130	Sandy Limestone, Light Gray, M. Hard							60
135.0 / 136.2	Shale, Light to Dark Gray, M. Soft			R-3	10.0/10.0	RQD = 67%		
140	Sandstone - Some Siltstone, Trace Soft Clay Seams, Gray, M. Hard							70

* ▽ Encountered Groundwater ▼ Composite Static Water Level **Recovered/Attempted

Use additional sheets with this format as necessary

2540-PM-LRWM0365 Rev. 2/2001

Borehole Number: B-214 (MW-214(A) / MW-214(B))

Surface Elevation (Ft./MSL): 1140.8 (ft)

Borehole Diameter: ~8 inches, From 0.0' To 120.0'

~3 inches, From 120.0' To 200.0'

Total Depth: 200.0' (ft)

Depth to Static Groundwater Level (SWL): 119.0' (ft)

Date SWL Measured: 07/18/05 (mm/dd/yy)

Drilling Method: 4¼" I.D. Hollow Stem Augers / NQ2 Coring

Date Drilled: 07/12/05 - 07/15/05 (mm/dd/yy)

Drilled By: Pennsylvania Drilling Co.

Drillers License Number: 0406

Logged By: J.E. Bonetti / R.W. Fandray

County: Greene

Township or Municipality: Monongahela Twp.

Depth (Ft)	Lithologic Description	Plot	Groundwater * Observations	Samples No.	Rec** / Att (Ft)	Comments	Well/Piezometer Construction	Depth (Ft)
140 – 146.4				R-4	10.0' / 10.0	RQD = 77%		
146.4 – 150.2	SHALE, DARK GRAY, M. SOFT							
150.2 – 160.9	LIMESTONE, TRACE SILTSTONE AND SHALE SEAMS, LIGHT GRAY, HARD			R-5	9.4 / 10.0	CLEAN OBLIQUE FRACTURES 152.4'-153.0', 154.9'-155.4'; RQD = 54%		10
160.9	COAL - BLACK SHALE, M. SOFT							20
162.0'	CLAYSTONE, GRAY, SOFT							
163.6'	CARBONACEOUS SHALE, SOFT							
– 167.9	LIMESTONE, GRAY HARD			R-6	10.0 / 10.0	CLEAN OBLIQUE FRACTURING AT 163.0' AND 165.0'; RQD = 48%		
167.9 – 175.9	SHALE - SOME CARBONACEOUS, DARK GRAY, M. SOFT			R-7	10.0 / 10.0	NEAR VERTICAL FRACTURE (CLEAN) AT 172.7'-174.1'; RQD = 59%		30
175.9 – 180	SILTY CLAYSTONE - SOME SOFT CLAY SEAMS AND NODULES, M. SOFT							
180 – 199.5'	SANDSTONE - TRACE CARBONACEOUS CROSS BEDDING, GRAY, M. HARD TO HARD (UNIONTOWN SANDSTONE)			R-8	9.5 / 10.0	WIDELY SPACED HORIZONTAL FRACTURES - SOME SLIGHTLY WEATHERED; RQD = 83%	180.0' SCREENED INTERVAL OF MONITORING WELL MW-214(B)	40
190				R-9	9.5 / 10.0	RQD = 70%		50
199.5' – 200	SHALE, DARK GRAY, M. SOFT						200.0'	60
200	B.O.H. @ 200.0'							70

* ▽ Encountered Groundwater ▼ Composite Static Water Level **Recovered/Attempted

Use additional sheets with this format as necessary

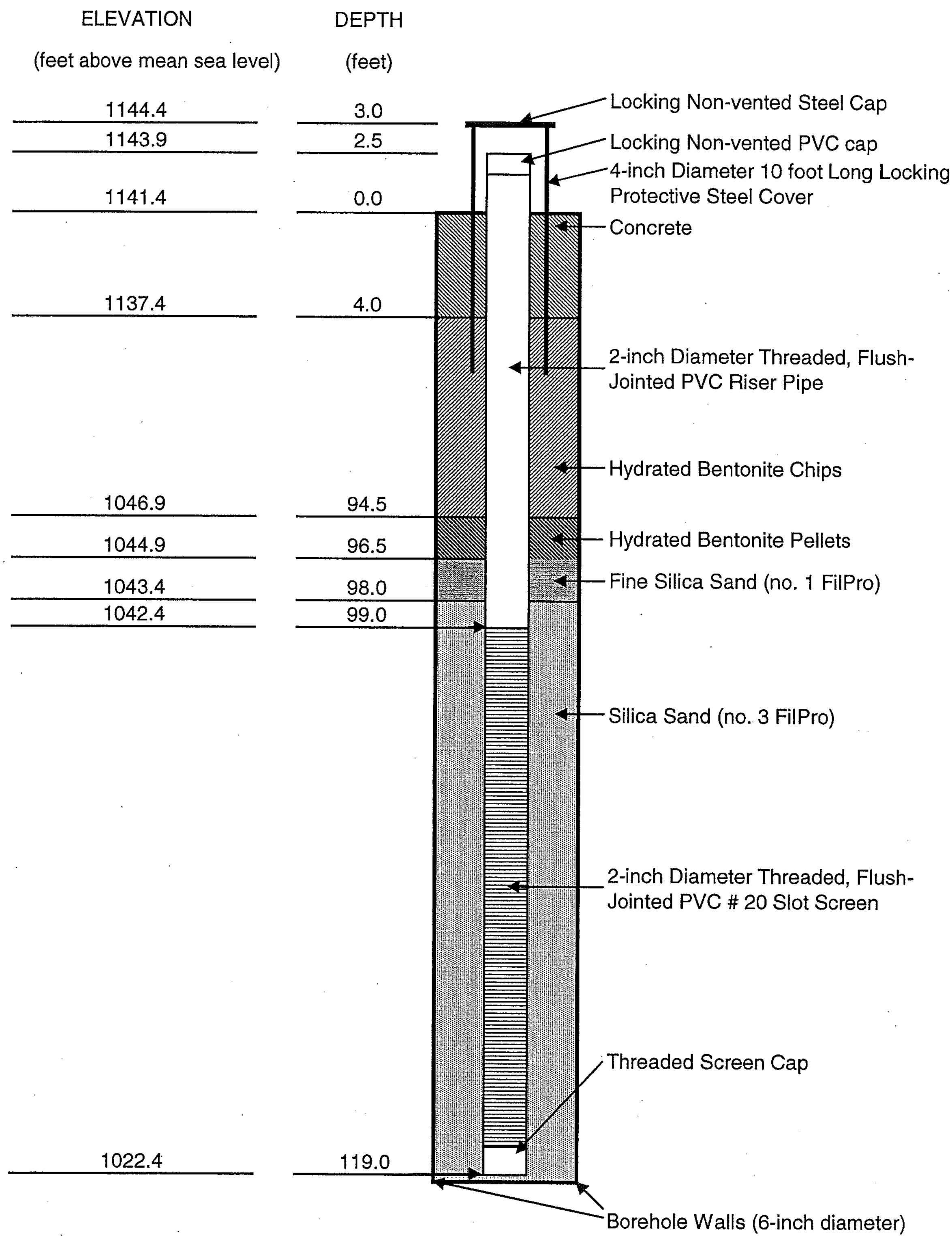
Northing: 195229.7916
Easting: 1350247.0310

PROJECT 2000-287-20

MW-214A

MONITORING WELL CONSTRUCTION DIAGRAM

HATFIELD'S FERRY POWER STATION, MASONTOWN, PENNSYLVANIA



not to scale

Installed August 8, 2005
Note: Elevations are calculated based on "top of steel" survey information.

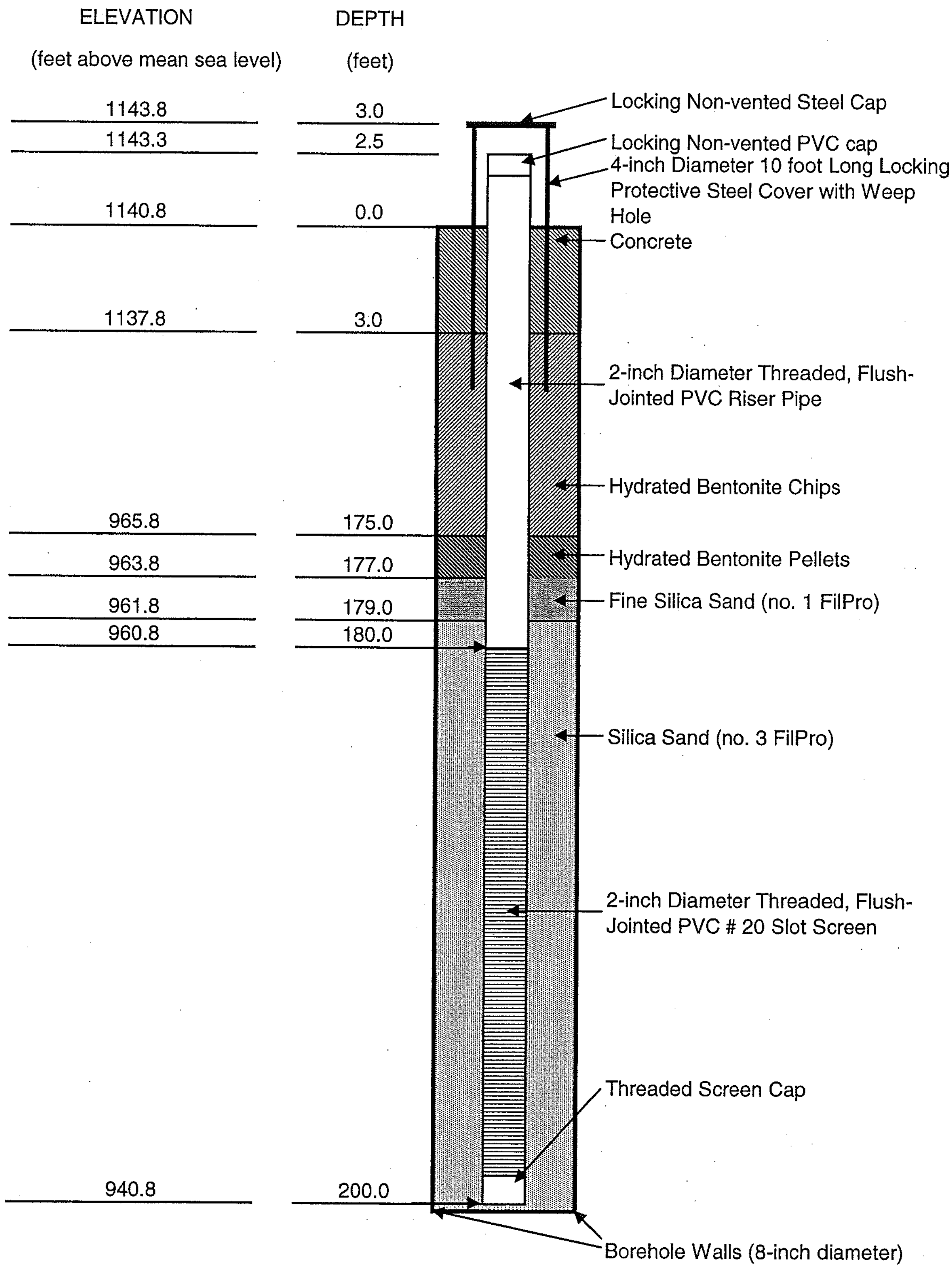
Northing: 195240.5785
Easting: 1350227.7280

PROJECT 2000-287-20

MW-214B

MONITORING WELL CONSTRUCTION DIAGRAM

HATFIELD'S FERRY POWER STATION, MASONTOWN, PENNSYLVANIA



not to scale

Installed July 26, 2005
Note: Elevations are calculated based on "top of steel" survey information.

P:\2000\2000-287\D20\Task 05 - form 7r\asbuilt 12 8 05MW-214B

2540-PM-LRWM0365 Rev. 2/2001

Borehole Number: B-217 (MW-217A)
Surface Elevation (Ft./MSL): 1138.8 (ft)
Borehole Diameter: 12 inches, From 0 To 61.5
_____ inches, From _____ To _____
Total Depth: 61.5 (ft)
Depth to Static Groundwater Level (SWL): 0hr-54.8' bgs (ft)
Date SWL Measured: 08-23-05 (mm/dd/yy)

Drilling Method: 4¼" ID Hollow Stem Augers/Ream with 6¼ ID augers
Date Drilled: 08-23-05 (mm/dd/yy)
Drilled By: Pennsylvania Drilling Co.
Drillers License Number: 0406
Logged By: R.W. Fandray
County: Greene
Township or Municipality: Monongahela Twp.

Depth (Ft)	Lithologic Description	Plot	Groundwater* Observations	Samples No.	Rec**/Att	Comments (BC = BLOW COUNT)	Well/Piezometer Construction
1.0	CLAYEY SILT						
5.0	SANDSTONE FRAGMENTS TRACE SANDY SILT (MINE SPOIL)			S-1	2.0/2.0	BROWN/TAN-HARD, DRY; GRAY/BROWN-DENSE; B.C. 4-16-25-23; *4.5 TSF	steel pipe - 3'; PVC pipe - 2.45'; concrete - 5'; riser - 42'; screen - 20'; coarse sand - 59.55'-39.3'; fine sand - 39.3'-38.1'; bentonite pellets - 38.1'-36.3'; bentonite chips - 36.3'-5'
10	SANDSTONE BOULDERS/COBBLES (MINESPOIL)			S-2	1.0/2.0	GRAY/TRACE BROWN MEDIUM DENSE-DRY; B.C. 16-7-7-6	
15.0	SANDSTONE AND SANDY SHALE FRAGMENTS (MINE SPOIL)			S-3	1.5/2.0	GRAY-DENSE-DRY; B.C. 9-12-34-15	
20	SANDSTONE FRAGMENTS AND SILTY CLAY (MINE SPOIL)			S-4	1.9/2.0	GRAY/BROWN-LOOSE; MOIST ZONE 16.5'-17.0'; B.C. 10-5-5-12	
	SANDSTONE FRAGMENTS SOME SILTY SAND (MINE SPOIL); 21.6' SILTY FLYASH		▽ Flyash wet @ 25'	S-5	2.0/2.0	BROWN/GRAY-VERY DENSE-DRY to MOIST; B.C. 13-23-28-10	
30				S-6	0.2/2.0	VERY LOOSE-WET; B.C. WOR-WOR-1-1	
				S-7	0.0/2.0	NO RECOVERY; SPOON WET UPON RETRIEVAL; B.C. WOR/2.0	
40	SOME CONSOLIDATED GRAVEL SIZED FLYASH			S-8	0.4/2.0	WET, PLACE BASKET IN SPOON FOR RECOVERY; B.C. WOR/2.0	
46.5				S-9	2.0/2.0	VERY SOFT, WET; B.C. WOR/2.0; *0.25 TSF	39.55' SCREENED INTERVAL
50	SILTY CLAY (MOTTLED)			S-10	2.0/2.0	BROWN/LIGHT BROWN VERY STIFF-MOIST; B.C. 2-2-2-4; *3.5 TSF	
55	SILTY CLAY-SOME SAND		▼ 53.6 (8/24) Thru augers	S-11	2.0/2.0	BROWN/GRAY-STIFF MOIST; B.C. 3-6-4-11; *1.75-2.0 TSF	
60	SILTY SAND-SOME CLAY			S-12	2.0/2.0	ORANGE/BROWN MEDIUM DENSE, MOIST; B.C. 9-12-13-15	59.55'
70	DECOMPOSED SANDSTONE; DECOMPOSED SHALE			S-13	1.3/1.5	ORANGE BROWN-BROWN MEDIUM-VERY DENSE MOIST; B.C. 8-9-50/0.5	

* ▽ Encountered Groundwater ▼ Composite Static Water Level **Recovered/Attempted

Use additional sheets with this format as necessary

★ Pocket penetrometer readings

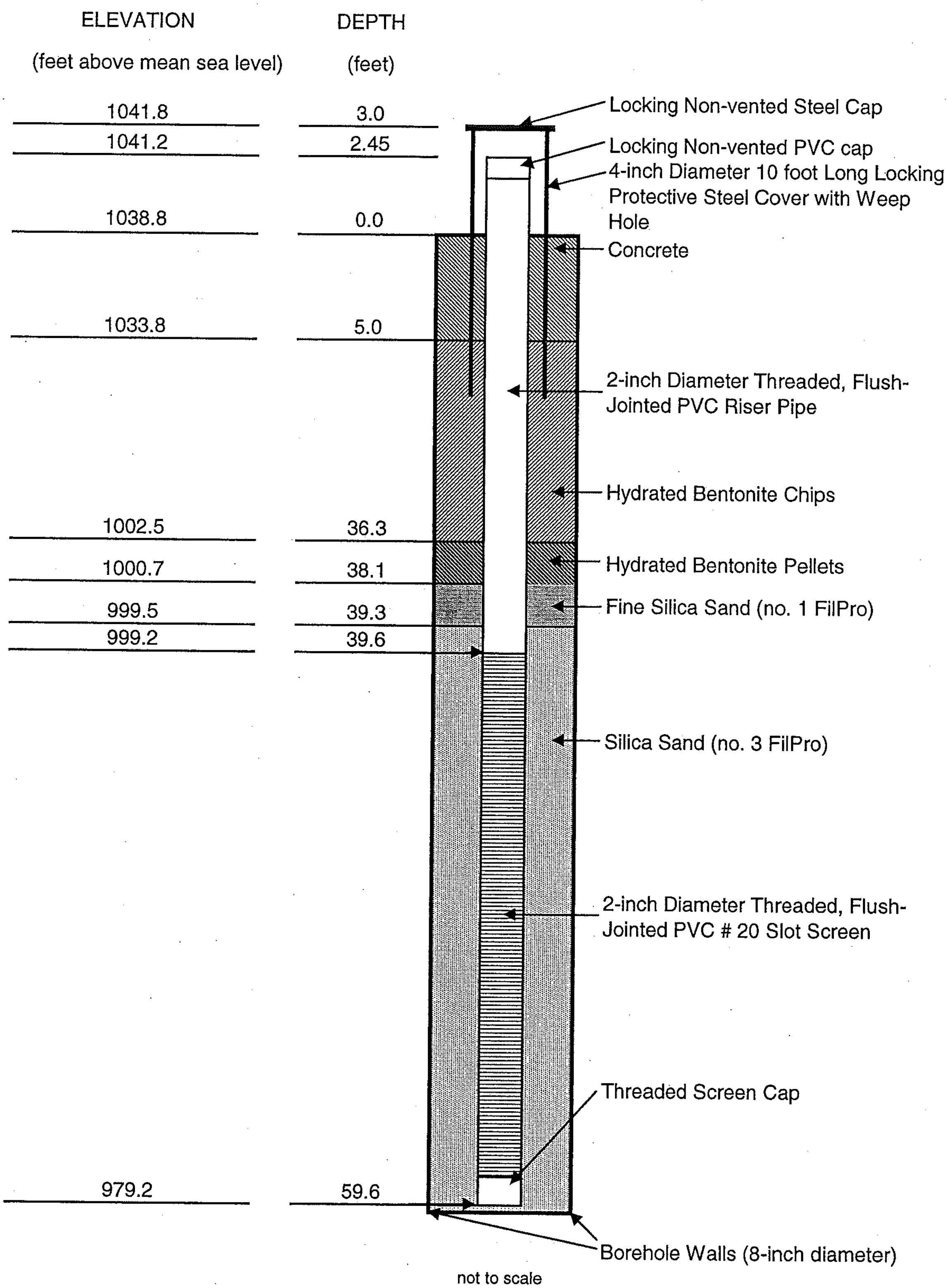
Northing: 196487.9667
Easting: 1353919.2680

PROJECT 2000-287-20

MW-217A

MONITORING WELL CONSTRUCTION DIAGRAM

HATFIELD'S FERRY POWER STATION, MASONTOWN, PENNSYLVANIA



Installed August 24, 2005
Note: Elevations are calculated based on "top of steel" survey information.

P:\2000\2000-287\D20\Task 05 - form 7r\asbuilt 12 8 05MW-217A

2540-PM-LRWM0365 Rev. 2/2001

Borehole Number: B-218 (MW-218 A)

Surface Elevation (Ft./MSL): 1139.0 (ft)

Borehole Diameter: 12 inches, From 0.0' To 65.0'

inches, From ___ To ___

Total Depth: 65.0' (ft)

Depth to Static Groundwater Level (SWL): 38.0' (ft)

Date SWL Measured: 08/30/05 (mm/dd/yy)

Drilling Method: 6 1/4 I.D. HSA

Date Drilled: 08/29/05-08/30/05 (mm/dd/yy)

Drilled By: PENNSYLVANIA DRILLING CO.

Drillers License Number: 6406

Logged By: A.L. BENEDICT

County: GREENE

Township or Municipality: MONONGAHELA

Depth (Ft)	Lithologic Description	Plot	Groundwater * Observations	Samples No.	Samples Rec** Att	Comments	Well/Piezometer Construction	Depth (Ft)
0–17.0	FINE SAND & SILT SOME SANDSTONE COBBLES & BOULDERS LITTLE CLAY					DRY TAN, LT. BROWN	steel pipe - 3' PVC pipe - 2.5' concrete - 5' riser - 47.5' screen - 20.0' coarse sand - 65.0'-44' fine sand - 44'-43' bentonite pellets - 43'-41' bentonite chips - 41'-5'	0–17
17.0	FLY ASH (SILTY) FILL					MOIST DK. GRAY		
30	SOME GRAVEL SIZED FRAGMENTS					DK. GRAY-OLIVE GRAY		30
38.0			▼ 38.0'					
45.0							45.0' SCREENED INTERVAL	
54			▽ 54.2'			WET @ 54.0'		
65.0	END BORING						65.0'	65

* ▽ Encountered Groundwater ▼ Composite Static Water Level **Recovered/Attempted

Use additional sheets with this format as necessary

Northing: 196615.4825
Easting: 1353940.0510

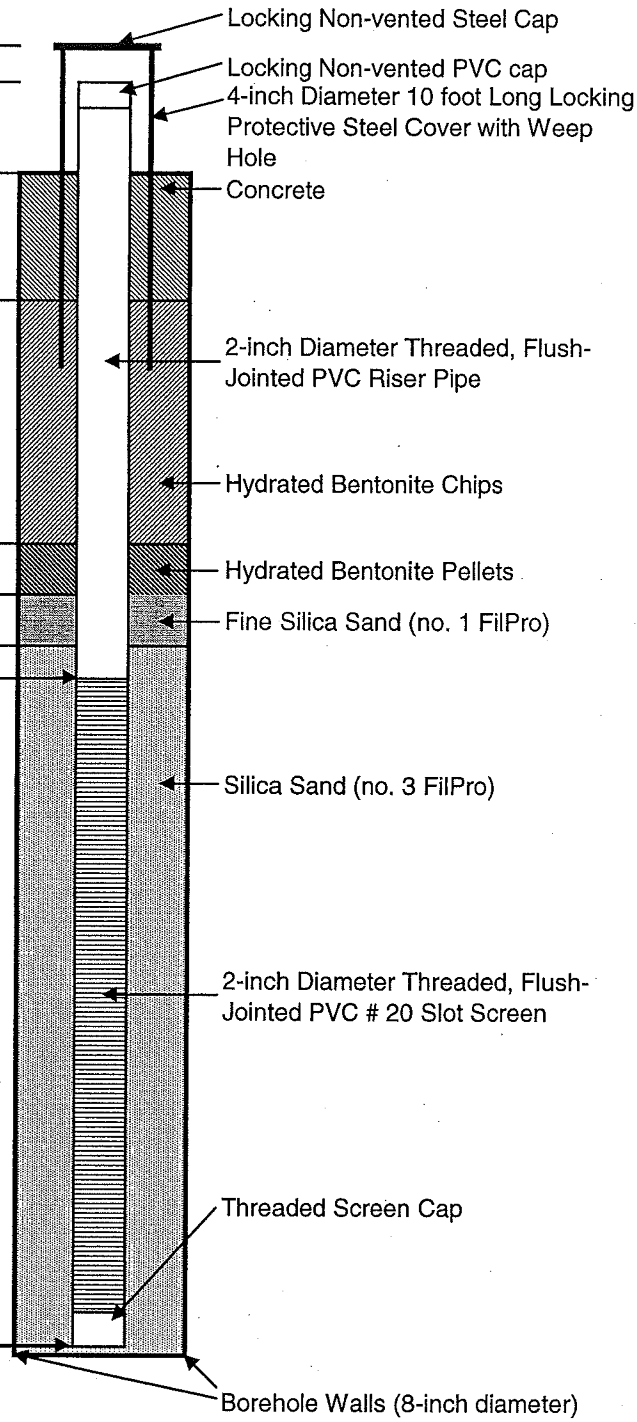
PROJECT 2000-287-20

MW-218A

MONITORING WELL CONSTRUCTION DIAGRAM

HATFIELD'S FERRY POWER STATION, MASONTOWN, PENNSYLVANIA

ELEVATION (feet above mean sea level)	DEPTH (feet)
1042.0	3.0
1041.5	2.5
1039.0	0.0
1034.0	5.0
998.0	41.0
996.0	43.0
995.0	44.0
994.0	45.0
974.0	65.0



not to scale

Installed August 30, 2005
Note: Elevations are calculated based on "top of steel" survey information.

Tetra Tech
661 Andersen Drive
Pittsburgh, Pennsylvania 15220
Telephone: 412-921-7090

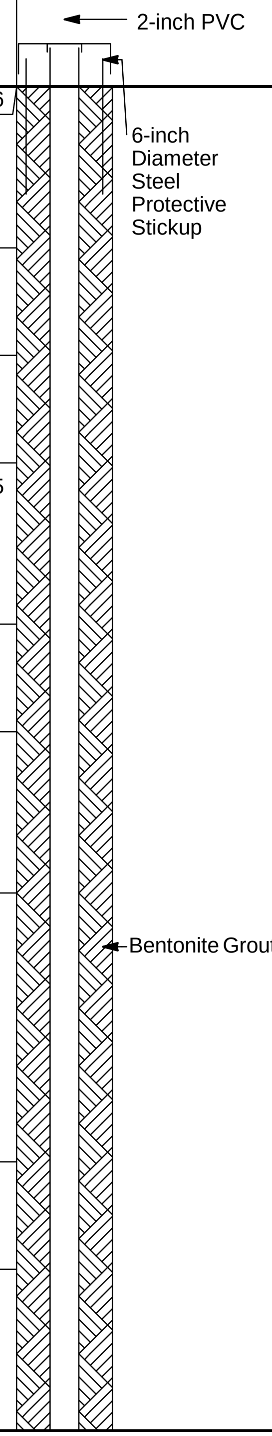
WELL NUMBER MW-222A

CLIENT First Energy
PROJECT NAME First Energy CCR, Hatfield Power Station
PROJECT NUMBER 212C-SW-00071
PROJECT LOCATION Hatfield's Ferry Power Station
DATE STARTED 5/16/19 **COMPLETED** 5/16/19
GROUND ELEVATION 1056.95 ft **HOLE SIZE** 7 1/4"
DRILLING CONTRACTOR Terra Testing
GROUND WATER LEVELS:
DRILLING METHOD HSA/SPT
AT TIME OF DRILLING ---
LOGGED BY D.Lapikas **CHECKED BY** J. Clara
AT END OF DRILLING ---
NOTES 5' Center Sampling
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	Depth / Elev.	MATERIAL DESCRIPTION	Environmental Data
0	SPT S-1	100	50/3	OH	0.3 / 1056.7	GRAVELLY SAND (OH), dark black to dark brown, moist, medium density w/ ORGANICS.	PID = 0.6
5	SPT S-2	100	16-12-17-22 (29)	SW	5.0 / 1052.0	GRAVELLY SAND (SW), light tan to light gray, moist, dense w/ some COARSE GRAVELS.	PID = 0 PID = 1
10	SPT S-3	100	7-5-5-5 (10)	CL	10.0 / 1047.0	SANDY CLAY (CL), light orange to light tan, moist, dense, low to medium plasticity w/ trace FINE SANDS.	PID = 0.5 PID = 0
15	SPT S-4	100	6-5-7 (12)	CL	15.0 / 1042.0	GRAVELLY CLAY (CL), light orange to light tan, moist, dense, low plasticity w/ some heavily-fractured COAL fragments.	PID = 0
20	SPT S-5	100	6-6-6-7 (12)	CL	22.0 / 1035.0	GRAVELLY CLAY (CL), light orange to light tan, moist, dense, low plasticity w/ some heavily-fractured COAL fragments.	PID = 0
25	SPT S-6	100	6-4-9-6 (13)	CL	25.0 / 1032.0	GRAVELLY CLAY (CL), light orange to light tan, moist, medium dense, medium to high plasticity w/ some trace FINE SANDS.	PID = 0

Casing Type: 2" PVC
Casing Top Elev: 1059.76 (ft)

WELL DIAGRAM



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CLIENT First Energy **PROJECT NAME** First Energy CCR, Hatfield Power Station

PROJECT NUMBER 212C-SW-00071 **PROJECT LOCATION** Hatfield's Ferry Power Station

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	Environmental Data	WELL DIAGRAM
25								
30	SPT S-7	100	5-4-8-10 (12)	CL		SANDY CLAY (CL), dark gray to dark orange, moist, dense, low to medium plasticity w/ MICACEOUS SHALE fragments. 30.0 1027.0	PID = 0.5 PID = 0.7	
35								Bentonite Seal
	SPT S-8	100	8-15-32-50/3	CL		GRAVELLY CLAY (CL), dark black to dark gray, saturated, dense, low to high plasticity w/ heavily-fractured COAL fragments and trace FINE SANDS. 37.0 1020.0	PID = 0.6 PID = 1.3	20-40 Silica Sand Filter Pack
40	SPT S-9	50	19-50/5			SHALE, modertate HSC reaction, highly weathered, thinly laminated, dark gray, very fine w/ some CLAYS and trace SILTS. 42.0 1015.0	PID = 0.2 PID = 0.4	0.010-inch Screened Interval
45								

Refusal at 45.0 feet.
Bottom of borehole at 45.0 feet.

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-2

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DATE STARTED 10/5/16 **COMPLETED** 10/6/16
ELEVATION 1058.28 ft **CASING ELEVATION** 1060.10
DRILLING CONTRACTOR Terra Testing
WELL INSTALLED Yes **STICKUP** 1.82
DRILLING METHOD Hollow Stem Auger with Continuous Split Spoon
OUTER CASING 2-inch PVC
DRILLER K. Little **CEC REP** T. Antonacci
DEVELOPMENT METHOD Bail and pump
DIAMETER 8-inch **CORE SIZE** 2-inch
RESULTS >10 well volumes removed
BACKFILL Piezometer installed
YIELD 65 gallons
MONITORING EQUIPMENT Water level only
LATITUDE 196695.09 **LONGITUDE** 1353029.90
KEY # None
WATER LEVELS
NOTES
BEFORE CORING ---
AT END OF DRILLING ---
AFTER DRILLING ---
WELL ON ---

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	REMARKS	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0						Ground surface (1058.3)	
0–11.0					Air knife from 0' to 6' bgs. Lithology from cuttings.	Brown silty CLAY, some gravel, some rock fragments, dry	Bentonite seal from 0' to 26' bgs
		SS 1	75	3-4-5-3 (9)			
		SS 2	60	6-4-2-2 (6)			
11.0–12.0		SS 3	100	2-5-6-7 (11)		(1047.3) Black silty CLAY, some coal fragments, dry	
12.0–18.0		SS 4	85	4-4-3-3 (7)		(1046.3) Dark gray silty CLAY, some shale fragments, some coal fragments, dry	
		SS 5	75	3-3-4-4 (7)			
		SS 6	100	9-11-11-12 (22)			
18.0–22.0		SS 7	85	5-5-5-4 (10)		(1040.3) Brown to gray silty CLAY, some gravel, dry	
		SS 8	70	3-3-5-7 (8)			
22.0		SS 9	80	3-4-6-6 (10)		(1036.3) Light brown clayey SAND, trace gravel, dry	
		SS 10	50	4-4-5-4 (9)			

(Continued Next Page)

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-2

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	X	SS 11	85	4-4-5-4 (9)			Light brown clayey SAND, trace gravel, dry *(continued)*	
30	X	SS 12	75	3-3-4-3 (7)			29.1 — 1029.2 Brown to gray sandy CLAY, some gravel, dry	
	X	SS 13	85	3-3-3-5 (6)				
	X	SS 14	100	4-4-5-2 (9)			Moist from 32' to 34' bgs 34.0 — 1024.3	Screened from 28' to 38' bgs with 0.01" slots
35	X	SS 15	75	2-2-25-50 (27)			Brown silty CLAY, some gravel, wet 35.5 — 1022.8 Black WEATHERED SHALE, dry	
	X	SS 16	85	18-50			Wet from 36.3' to 37.5' bgs 37.5 — 1020.8 38.0 — 1020.3 Light gray SHALE, dry	

Bottom of boring at 38.0 feet.

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-3

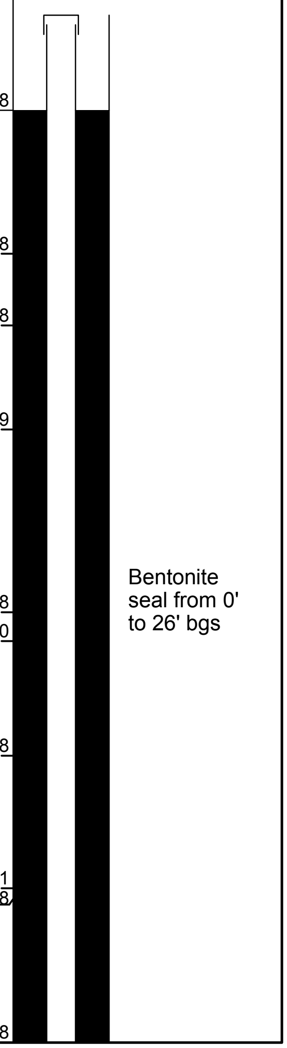
CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DATE STARTED 10/4/16 **COMPLETED** 10/4/16
ELEVATION 1054.84 ft **CASING ELEVATION** 1057.49
DRILLING CONTRACTOR Terra Testing
WELL INSTALLED Yes **STICKUP** 2.65
DRILLING METHOD Hollow Stem Auger with Continuous Split Spoon
OUTER CASING 2-inch PVC
DRILLER K. Little **CEC REP** T. Antonacci
DEVELOPMENT METHOD Bail and pump
DIAMETER 8-inch **CORE SIZE** 2-inch
RESULTS >10 well volumes removed
BACKFILL Piezometer installed
YIELD 19 gallons
MONITORING EQUIPMENT Water level only
LATITUDE 197026.46 **LONGITUDE** 1353574.04
KEY # None
WATER LEVELS
NOTES
BEFORE CORING ---
AT END OF DRILLING ---
AFTER DRILLING ---
WELL ON ---

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	GRAPHIC LOG
0–2		SS 1	70	10-26-34-42 (60)	
2–4		SS 2	70	7-30-30-27 (60)	
4–6		SS 3	40	7-20-14-10 (34)	
6–8		SS 4	35	8-8-7-7 (15)	
8–10		SS 5	100	3-4-8-9 (12)	
10–12		SS 6	100	4-8-4-4 (12)	
12–14		SS 7	45	5-7-7-9 (14)	
14–16		SS 8	100	8-11-10-3 (21)	
16–18		SS 9	65	8-11-13-10 (24)	
18–20		SS 10	100	8-7-7-5 (14)	
20–22		SS 11	70	4-4-4-3 (8)	
22–24		SS 12	45	4-4-4-7 (8)	
24–26		SS 13	65	8-15-18-50 (33)	

DEPTH	MATERIAL DESCRIPTION	ELEVATION
0.0	Ground surface	1054.8
0.0–4.0	Dark gray WEATHERED SHALE, some sandstone fragments, dry	1050.8
4.0–6.0	Brown clayey SILT, some sand, some gravel, dry	1048.8
6.0–8.9	Brown silty SAND, some sandstone fragments, dry	1045.9
8.9–14.0	Dark gray silty CLAY, some shale fragments, dry	1040.8
14.0–14.8	Light brown silty CLAY, trace gravel, moist	1040.0
14.8–18.0	Light gray SANDSTONE FRAGMENTS, dry	1036.8
18.0–21.7	Light brown to orange sandy CLAY, trace sandstone fragments, dry	1033.1
21.7–22.0	Black COAL FRAGMENTS, dry	1032.8
22.0–26.0	Black silty CLAY, some coal fragments, dry	1028.8

WELL DIAGRAM



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Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

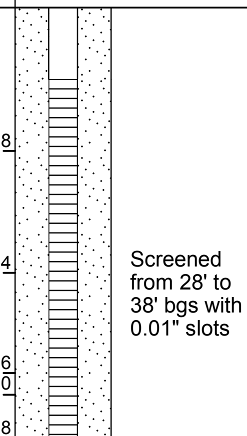
WELL NUMBER PZ-3

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	GRAPHIC LOG	MATERIAL DESCRIPTION
		SS 14	0	50		Gray SANDSTONE FRAGMENTS, dry
		SS 15	65	17-13-4-7 (17)		
30		SS 16	40	8-8-6-8 (14)		30.0 — Brown to orange silty CLAY, some sandstone fragments, dry — 1024.8
		SS 17	100	7-11-50 (61)		33.4 — Dark gray WEATHERED SHALE, dry — 1021.4
35		SS 18	60	7-45-50 (95)		
		SS 19	45	43-50		36.2 — Dark gray silty CLAY, some gravel, wet — 1018.6
						36.8 — Light gray CLAYSTONE, dry — 1018.0
						38.0 — 1016.8

Bottom of boring at 38.0 feet.

WELL DIAGRAM



Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-4

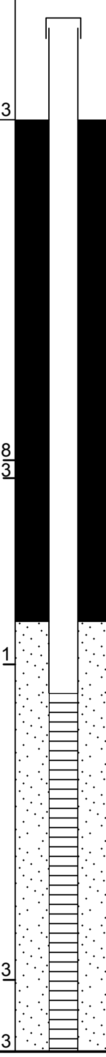
CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DATE STARTED 10/7/16 **COMPLETED** 10/10/16
ELEVATION 1053.32 ft **CASING ELEVATION** 1056.16
DRILLING CONTRACTOR Terra Testing
WELL INSTALLED Yes **STICKUP** 2.84
DRILLING METHOD Hollow Stem Auger with Continuous Split Spoon
OUTER CASING 2-inch PVC
DRILLER K. Little **CEC REP** T. Antonacci
DEVELOPMENT METHOD Bail and pump
DIAMETER 8-inch **CORE SIZE** 2-inch
RESULTS >10 well volumes removed
BACKFILL Piezometer installed
YIELD 28 gallons
MONITORING EQUIPMENT Water level only
LATITUDE 196491.28 **LONGITUDE** 1353465.72
KEY # None
WATER LEVELS
NOTES
BEFORE CORING ---
AT END OF DRILLING ---
AFTER DRILLING ---
WELL ON ---

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	REMARKS
0–6					Air knife from 0' to 6' bgs. Lithology from cuttings.
6–8	SS	SS 1	70	3-3-3-2 (6)	
8–10	SS	SS 2	60	3-4-5-7 (9)	
10–12	SS	SS 3	75	4-2-2-3 (4)	
12–14	SS	SS 4	55	3-3-3-4 (6)	
14–16	SS	SS 5	100	1-2-4-6 (6)	
16–18	SS	SS 6	35	4-3-3-4 (6)	
18–20	SS	SS 7	55	4-3-3-4 (6)	
20–22	SS	SS 8	100	3-3-4-4 (7)	
22–24	SS	SS 9	70	1-1-2-7 (3)	
24–26	SS	SS 10	60	1-2-7-5 (9)	

Depth (ft)	MATERIAL DESCRIPTION	Elevation
0.0	Ground surface	1053.3
0.0–9.5	Black COAL COMBUSTION BY-PRODUCTS, dry	1043.8
9.5–10.0	Brown clayey SILT, dry	1043.3
10.0–15.2	Gray COAL COMBUSTION BY-PRODUCTS, dry	1038.1
15.2–24.0	Brown silty CLAY, some rock fragments, dry Moist from 20' to 24' bgs	1029.3
24.0–26.0	Brown clayey SILT, dry	1027.3

WELL DIAGRAM



Bentonite seal from 0' to 14' bgs

(Continued Next Page)

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-4

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	RECOVERY %	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
		SS 11	80	2-4-5-6 (9)			Brown silty CLAY, some gravel, dry	Screened from 16' to 36' bgs with 0.01" slots
30		SS 12	90	2-8-9-12 (17)				
		SS 13	100	8-13-17-34 (30)			31.0 — 1022.3 Brown WEATHERED CLAYSTONE, dry	
		SS 14	100	25-50				
35		SS 15	55	25-50				
		SS 16	70	25-25				Cave in from 36' to 40' bgs
40		SS 17	40	50	Auger refusal at 40' bgs.		40.0 — 1013.3	

Bottom of boring at 40.0 feet.

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-5

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DATE STARTED 10/6/16 **COMPLETED** 10/7/16
ELEVATION 1058.02 ft **CASING ELEVATION** 1060.09
DRILLING CONTRACTOR Terra Testing
WELL INSTALLED Yes **STICKUP** 2.07
DRILLING METHOD Hollow Stem Auger with Continuous Split Spoon
OUTER CASING 2-inch PVC
DRILLER K. Little **CEC REP** T. Antonacci
DEVELOPMENT METHOD Bail and pump
DIAMETER 8-inch **CORE SIZE** 2-inch
RESULTS >10 well volumes removed
BACKFILL Piezometer installed
YIELD 21 gallons
MONITORING EQUIPMENT Water level only
LATITUDE 196539.06 **LONGITUDE** 1353206.70
KEY # None
WATER LEVELS
NOTES
BEFORE CORING ---
AT END OF DRILLING ---
AFTER DRILLING ---
WELL ON ---

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEV.
0.0						Ground surface	1058.0
				Air knife from 0' to 6' bgs. Lithology from cuttings.		Black COAL COMBUSTION BY-PRODUCTS, dry	
		SS 1	4-2-3-3 (5)				
8.9		SS 2	2-2-3-3 (5)			Dark brown silty CLAY, some rock fragments, dry	1049.1
		SS 3	2-2-6-6 (8)				
		SS 4	6-5-5-4 (10)				
14.0		SS 5	6-7-5-8 (12)			Gray SAND, some sandstone fragments, dry	1044.0
16.0		SS 6	10-8-7-6 (15)			Brown silty CLAY, some sand, some rock fragments, dry	1042.0
19.4		SS 7	6-4-5-6 (9)			Gray WEATHERED SHALE, dry	1038.6
20.0		SS 8	6-7-6-6 (13)			Dark brown silty CLAY, some rock fragments, moist	1038.0
		SS 9	6-2-4-3 (6)				
25		SS 10	3-2-3-3 (5)			Dry from 24' to 26'.6' bgs	

WELL DIAGRAM

Bentonite seal from 0' to 26' bgs

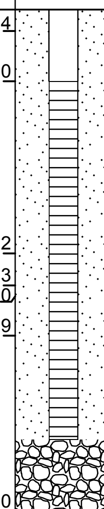
(Continued Next Page)

Civil & Environmental Consultants, Inc.
4000 Triangle Lane, Suite 200
Export, PA 15632

WELL NUMBER PZ-5

CLIENT FirstEnergy Generation, LLC
PROJECT NAME Hatfield's Ferry Power Station CCB Landfill
PROJECT NUMBER 143-374.08
PROJECT LOCATION Monongahela Township, Greene County, Pennsylvania

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	BLOW COUNTS (N VALUE)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
		SS 11	2-2-2-4 (4)			26.6 — 1031.4 Gray SANDSTONE FRAGMENTS, dry	
30		SS 12	18-14-14-6 (28)			28.0 — 1030.0 Gray silty CLAY, some shale fragments, dry	
		SS 13	13-13-19-16 (32)				
		SS 14	7-6-5-6 (11)			32.8 — 1025.2 Black WEATHERED SHALE, dry 33.7 — 1024.3 34.0 — 1024.0 Gray WEATHERED CLAYSTONE, dry	Screened from 28' to 38' bgs with 0.01" slots
35		SS 15	18-28-50 (78)			35.1 — 1022.9 Gray silty CLAY, wet Gray WEATHERED SHALE, dry	
		SS 16	50				
40		SS 17	50			40.0 — 1018.0	Cave in from 38' to 40' bgs



Bottom of boring at 40.0 feet.

APPENDIX C

Geologic Cross-Sections J-J' and L-L'

MONITORING WELL LOCATION

NUMBER	NORTHING	EASTING
MW-201CD	198,108.957	1,352,107.555
MW-202BD	197,544.556	1,351,859.153
MW-202CD	197,531.636	1,351,845.794
MW-203BD	197,309.813	1,352,283.311
MW-203CD	197,325.679	1,352,270.176
MW-204BD	197,337.360	1,351,989.323
MW-205AU	196,236.517	1,352,629.697
MW-205BU	196,270.208	1,352,630.056
MW-205CU	196,282.904	1,352,650.896
MW-206AU	196,069.737	1,351,807.723
MW-206BU	196,081.790	1,351,812.726
MW-206CU	196,094.393	1,351,817.322
MW-207AU	196,360.432	1,350,802.436
MW-207BU	196,343.183	1,350,791.733
MW-207CU	196,372.406	1,350,811.211
MW-208CD	197,963.476	1,352,167.931
MW-209A	195,674.019	1,353,058.309
MW-209B	195,680.490	1,353,050.637
MW-209C	195,691.591	1,353,036.008
MW-210A	194,403.708	1,351,801.349
MW-210B	194,403.617	1,351,786.538
MW-210C	194,405.961	1,351,771.853
MW-211A	195,728.447	1,350,625.027
MW-211C	195,730.642	1,350,637.286
MW-212A	193,859.828	1,351,127.567
MW-212B	193,877.794	1,351,140.437
MW-213A	194,665.360	1,349,731.896
MW-213B	194,684.142	1,349,733.176
MW-214A	195,229.792	1,350,247.031
MW-214B	195,240.579	1,350,227.728
MW-215A	196,207.343	1,349,134.755
MW-215B	196,194.095	1,349,115.370
MW-216A	196,582.637	1,353,153.015
MW-217A	196,487.967	1,353,919.268
MW-218A	196,615.483	1,353,940.057
MW-219A	196,952.882	1,353,560.617

LEGEND

- MP-1D — MONITORING WELLS (ABANDONED)
- UT-1 — SURFACE WATER (〈 =DIRECTION OF FLOW)
- PIEZOMETER (ABANDONED)
- P-210 (968.7) — TEST BORING LOCATION
- TP01-1 — TEST PIT LOCATION
- MW-213B (945.4) — MONITORING WELLS (200 SERIES)
  - A = SCREENED IN MINE SPOIL
  - B = SCREENED IN UNIONTOWN SANDSTONE
  - C = SCREENED IN BENWOOD LIMESTONE
- (945.4) — ELEVATION OF TOP OF UNIONTOWN COAL
- DP-1LC/D — LEACHATE COLLECTION OR UNDERDRAIN DISCHARGE POINT
- SP-1 — SPRING
- LW1 — LITTLE WHITELY CREEK MONITORING POINT
- Or — RECLAIMED MINE SPOIL
- Pm — MONONGAHELA GROUP
- Pw — DUNKARD GROUP WAYNESBURG FORMATION
- INFERRED FORMATION CONTACT
- 950 — STRUCTURAL CONTOURS DRAWN ON THE TOP OF THE UNIONTOWN COAL
- 650 — STRUCTURAL CONTOURS DRAWN ON THE TOP OF THE PITTSBURGH COAL
- PROPOSED FACILITY BOUNDARY AND PROPERTY LINE
- PROPOSED FACILITY BOUNDARY ONLY
- PROPERTY LINE ONLY
- OUTLINE OF PROPOSED LANDFILL
- OUTLINE OF EXISTING LANDFILL
- AXIS OF LAMBERT SYNCLINE BASED ON SITE SPECIFIC INFORMATION (STRUCTURE CONTOURS OF BASE OF UNIONTOWN COAL)
- AXIS OF LAMBERT SYNCLINE (FROM STONER ET AL 1987)
- K / C83503666 — GEOLOGIC SECTION LINE AND DRAWING REFERENCE NUMBER

SCALE 1"=200'
200 0 200 400

This drawing was produced with computer aided drafting technology and is supported by electronic drawing files. Do not revise this drawing via manual drafting methods.

NO.	DATE	DWN	CHKD	APPVD	DESCRIPTION
A	11/19/07	EJM	RJT	JDP	EXTEND CROSS-SECTION J-J THROUGH P-107B, P-102-B, AND P-101C. ADDED LIMITS OF EXISTING AND PROPOSED DISPOSAL AREA AND PROPOSED LEACHATE STORAGE IMPOUNDMENT

NO. CHKD REVISIONS

JOSEPH D. PHILLIPS — PROFESSIONAL ENGINEER

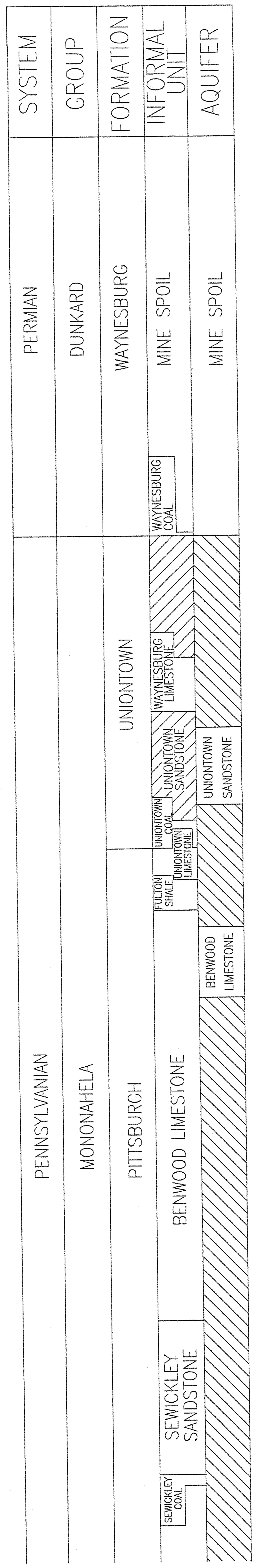
ALLEGHENY ENERGY SUPPLY COMPANY, LLC
HATFIELD'S FERRY POWER STATION
CCB LANDFILL

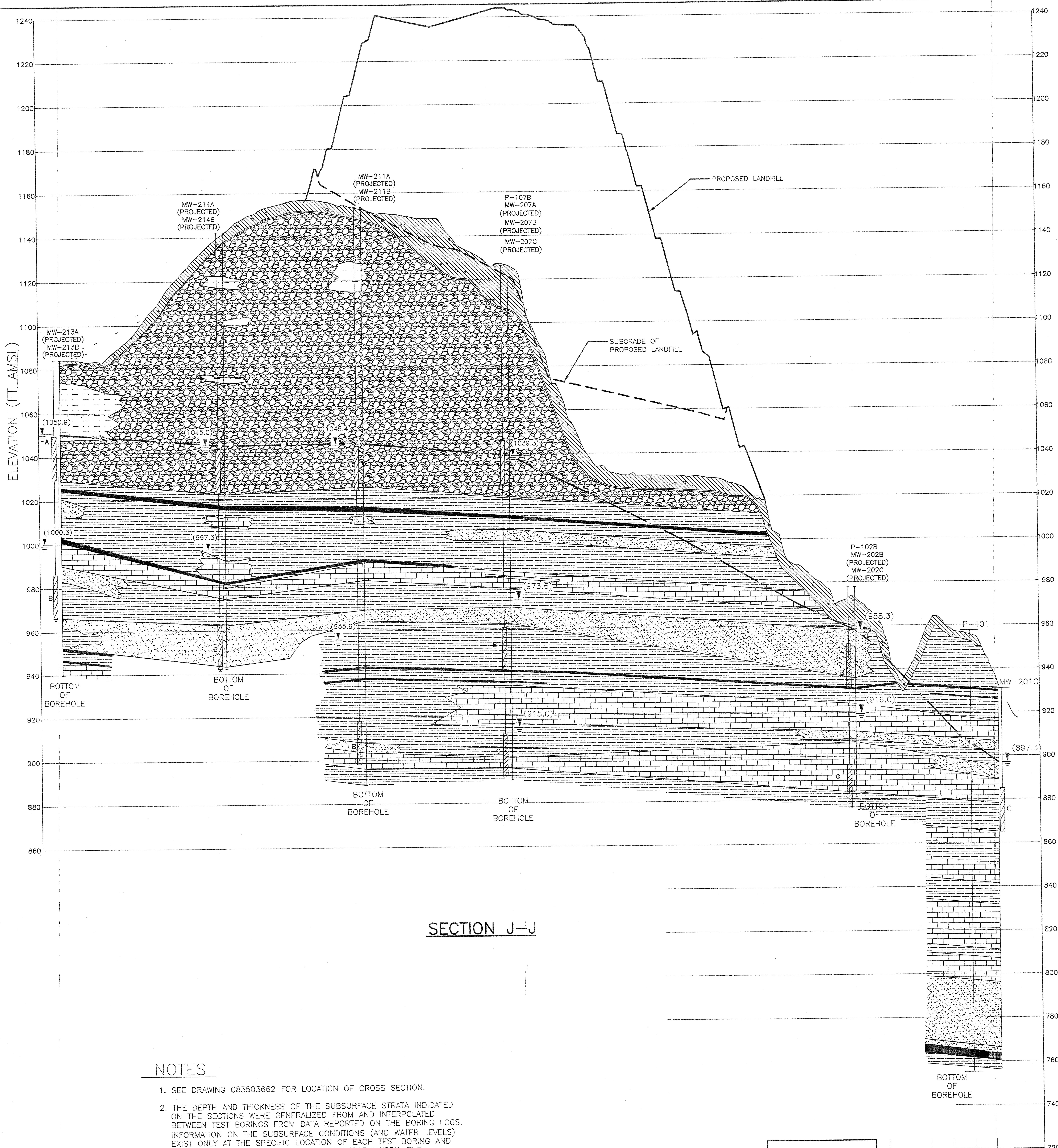
GEOLOGIC MAP

DRAWN SG/JCN
CHECKED JEB
APPROVED JDP
DATE 2/8/06
TASK NO. 04
PROJECT NO./DASH NO. 2000-287-16
DRAWING NO. C83503662
SCALE: 1"=200' SHT. NO. ___ OF ___
REV A

gai consultants
PITTSBURGH OFFICE • 385 EAST WATERFRONT DRIVE, HOMESTEAD, PA 15120-5005
GAI DRAWING FILE NO. 2000-287-16-04-E-F013

PLOTTER FILE: AP-GAI.CTB
GAI CAD FILE: P:\2000\2000-287\D16\CADD\2000-287-F013.DWG 10/4/07





SECTION J-J

LEGEND

- CLAYEY SILT TRACE ROCK FRAGMENTS
- FLY ASH
- MINE SPOIL
- UNCONSOLIDATED SOIL AND FILL
- SHALE AND CLAYSTONE
- SANDSTONE AND SILTSTONE
- LIMESTONE
- COAL

ESTIMATED WATER TABLE BASED ON MAXIMUM HYDRAULIC HEADS IN THE FIRST CONTINUOUS AQUIFER – TAKEN FROM "GROUND WATER CONTOUR MAP, FIRST CONTINUOUS AQUIFER, MAXIMUM GROUND WATER ELEVATION, OCTOBER 2005 – OCTOBER 2007" NOTE THAT REGIONAL WATER TABLE IS AT OR BELOW THE BENWOOD LIMESTONE (TOP AT ABOUT ELEVATION 920 FEET)

MW-210A–MONITORING WELL DESIGNATION

C (943.6) WELL SCREEN WITH WATER ELEVATION, LEVEL IS MAXIMUM ELEVATION, MEASURED OCTOBER 2005 – OCTOBER 2007

A = SCREENED IN MINE SPOIL/WAYNESBURG FORMATION
B = SCREENED IN UNIONTOWN SANDSTONE
C = SCREENED IN BENWOOD LIMESTONE

NOTES

1. SEE DRAWING C83503662 FOR LOCATION OF CROSS SECTION.
2. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN TEST BORINGS FROM DATA REPORTED ON THE BORING LOGS. INFORMATION ON THE SUBSURFACE CONDITIONS (AND WATER LEVELS) EXIST ONLY AT THE SPECIFIC LOCATION OF EACH TEST BORING AND AT THE PARTICULAR TIMES OF THE EXPLORATORY WORK. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL AND/OR ROCK TYPES AND THE TRANSITION MAY BE GRADUAL. IT IS POSSIBLE THAT THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE SUBSURFACE CONDITIONS (AND/OR WATER LEVELS) AT THESE BORING LOCATIONS AND THAT THE SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.
3. SCREENED INTERVALS WERE TARGETED FOR SPECIFIC STRATIGRAPHIC INTERVALS. NOTE THAT SPECIFIC STRATIGRAPHIC INTERVALS MAY GRADE LOCALLY INTO DIFFERENT ROCK TYPES.

200 100 0 200
HORIZONTAL SCALE 1" = 200'

40 20 0 40
VERTICAL SCALE 1" = 20'

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL JOSEPH D. PHILLIPS ENGINEER NO. 33417-E

NO.	DATE	DWN	CHKD	APPVD	DESCRIPTION
A	11/19/07	EJM	RJT	JDP	ADD AXIS OF LAMBERT SYNCLINE FROM STONER ET AL 1987 AND FROM SITE SPECIFIC CONTOURS OF THE TOP OF UNIONTOWN COAL. REVISED ESTIMATED WATER TABLE AND ADDED PROPOSED LANDFILL SUBGRADE. REMOVED SECTION K-K

REVISIONS

This drawing was produced with computer aided drafting technology and is supported by electronic drawing files. Do not revise this drawing via manual drafting methods.

ALLEGHENY ENERGY SUPPLY COMPANY, LLC
HATFIELD'S FERRY POWER STATION
CCB LANDFILL

GEOLOGIC CROSS SECTION J-J

DRAWN FJC | APPROVED JDP
CHECKED JEB | DATE 2/8/06
TASK NO. 05
PROJECT NO./DASH NO. 2000-287-20
DRAWING NO. C83503666 REV A
SCALE: AS NOTED SHT. NO. – OF –

gai consultants
PITTSBURGH OFFICE • 385 EAST WATERFRONT DRIVE, HOMESTEAD, PA 15120-5005
GAI DRAWING FILE NO. 2000-287-20-05-E-F018

SECTION L–L

LEGEND

- CLAYEY SILT TRACE ROCK FRAGMENTS
- FLY ASH
- MINE SPOIL
- UNCONSOLIDATED SOIL AND FILL
- SHALE AND CLAYSTONE
- SANDSTONE AND SILTSTONE
- LIMESTONE
- COAL
- ESTIMATED WATER TABLE BASED ON MAXIMUM HYDRAULIC HEADS IN THE FIRST CONTINUOUS AQUIFER – TAKEN FROM "GROUND WATER CONTOUR MAP, FIRST CONTINUOUS AQUIFER, MAXIMUM GROUND WATER ELEVATION, OCTOBER 2005 – OCTOBER 2007" NOTE THAT REGIONAL WATER TABLE IS AT OR BELOW THE BENWOOD LIMESTONE (TOP AT ABOUT ELEVATION 920 FEET)

MW–210A–MONITORING WELL DESIGNATION

C (852.4) WELL SCREEN WITH WATER ELEVATION, LEVEL IS MAXIMUM ELEVATION, MEASURED OCTOBER 2005 – OCTOBER 2007

A = SCREENED IN MINE SPOIL/WAYNESBURG FORMATION
B = SCREENED IN UNIONTOWN SANDSTONE
C = SCREENED IN BENWOOD LIMESTONE

NOTES

1. SEE DRAWING C83503662 FOR LOCATION OF CROSS SECTION.
2. THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN TEST BORINGS FROM DATA REPORTED ON THE BORING LOGS. INFORMATION ON THE SUBSURFACE CONDITIONS (AND WATER LEVELS) EXIST ONLY AT THE SPECIFIC LOCATION OF EACH TEST BORING AND AT THE PARTICULAR TIMES OF THE EXPLORATORY WORK. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL AND/OR ROCK TYPES AND THE TRANSITION MAY BE GRADUAL. IT IS POSSIBLE THAT THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE SUBSURFACE CONDITIONS (AND/OR WATER LEVELS) AT THESE BORING LOCATIONS AND THAT THE SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.
3. SCREENED INTERVALS WERE TARGETED FOR SPECIFIC STRATIGRAPHIC INTERVALS. NOTE THAT SPECIFIC STRATIGRAPHIC INTERVALS MAY GRADE LOCALLY INTO DIFFERENT ROCK TYPES.

200 100 0 200
HORIZONTAL SCALE 1" = 100'

100 50 0 100
VERTICAL SCALE 1" = 50'

REGISTERED PROFESSIONAL JOSEPH D. PHILLIPS ENGINEER NO. 33417-E

NO.	DATE	DWN	CHKD	APPVD	DESCRIPTION
A	11/19/07	EJM	RJT	JDP	ADD AXIS OF LAMBERT SYNCLINE FROM STONER ET AL 1987 AND FROM SITE SPECIFIC CONTOURS OF THE TOP OF UNIONTOWN COAL. REVISED ESTIMATED WATER TABLE AND ADDED PROPOSED LANDFILL SUBGRADE

REVISIONS

ALLEGHENY ENERGY SUPPLY COMPANY, LLC
HATFIELD'S FERRY POWER STATION
CCB LANDFILL

GEOLOGIC CROSS SECTION L–L

DRAWN FJC APPROVED JDP
CHECKED JEB DATE 2/8/06
TASK NO. 05
PROJECT NO./DASH NO. 2000-287-20
DRAWING NO. C83503667
SCALE: AS NOTED SHT. NO. ___ OF ___ REV A

gai consultants
PITTSBURGH OFFICE • 385 EAST WATERFRONT DRIVE, HOMESTEAD, PA 15120-5005
GAI DRAWING FILE NO. 2000-287-20-05-E-F019

GAI CAD FILE: 2000-287-20-05-E-F019.DWG 1/4/08