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OCT 1 1 2019

Mr. Joe Tarantino, Acting Prime Contract Manager
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PPPO-02-10001117-20

Dear Mr. Tarantino:

DE-EM0004895: APPROVAL OF FINAL ENVIRONMENTAL MONITORING PLAN FISCAL YEAR 2020, PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, CP2-ES-0006/FR5

Reference: Letter from M. Redfield to M. Fultz, "Four Rivers Nuclear Partnership, LLC, Deliverable No. 42—FINAL *Environmental Monitoring Plan Fiscal Year 2020, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR5," (FRNP-20-3009), dated October 3, 2019

The U.S. Department of Energy (DOE) reviewed the referenced document for compliance with DOE requirements. The plan is approved. If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Marcia D. Fultz
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CP2-ES-0006/FR5

Environmental Monitoring Plan
Fiscal Year 2020
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

This document is approved for public release per review by:

David Hayden — FRNP Classification Support

10-2-19 — Date

CP2-ES-0006/FR5

Environmental Monitoring Plan
Fiscal Year 2020
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

Date Issued—October 2019

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

Total Pages: 246

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ACRONYMS

AEC	Atomic Energy Commission
AIP	Agreement in Principle
ASER	Annual Site Environmental Report
CAP-88	Clean Air Act Assessment Package-88
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CY	calendar year
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	data quality objective
DUF_6	depleted uranium hexafluoride
ED	effective dose
EDE	effective dose equivalent
EM	environmental monitoring
EMP	Environmental Monitoring Plan
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ERPP	Environmental Radiation Protection Program
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
GSA	General Services Administration
ISMS	Integrated Safety Management System
KAR	*Kentucky Administrative Regulation*
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
MCS	Mid-America Conversion Services, LLC
MDA	minimum detectable activity
MDL	method detection limit
MEI	maximally exposed individual
MW	monitoring well
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
O	Order
O&M	operation and maintenance
OREIS	Paducah Oak Ridge Environmental Information System
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PQL	practical quantification limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation

ROD	record of decision
SARA	Superfund Amendments Reauthorization Act
SDWA	Safe Drinking Water Act
SPCC	spill prevention control and countermeasure
SSPP	Strategic Sustainability Performance Plan
SWMU	solid waste management unit
TED	total effective dose
TLD	thermoluminescent dosimeter
USEC	United States Enrichment Corporation
WKWMA	West Kentucky Wildlife Management Area
WMP	Watershed Monitoring Plan

EXECUTIVE SUMMARY

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2020 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance management.

EM at the Paducah Site consists of effluent monitoring and environmental surveillance activities and supports the evaluation and assessment of unplanned releases. Monitoring is conducted for a variety of media including air, surface water, groundwater, and sediment.

This EMP is comprised of the main text that details rationale and objectives, as well as four appendices. Appendix A is a summary of the Paducah Site permits and agreements; Appendix B is a well inventory; Appendix C lists all individual sampling programs, along with their sampling frequencies, methods, action limits, and parameter lists; and Appendix D contains the quality assurance project plan for executing the work described in this EMP.

Sampling frequencies and sampling parameters that were modified for a sampling program that was permit-driven or collected as a result of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) decision document were changed only if the permit allowed the change. Data collected under existing permits and under CERCLA or RCRA decision documents will continue to be evaluated in FY 2020. If changes are deemed appropriate based on trending analyses, they will be proposed via a permit modification or decision document change (as applicable) and implemented immediately after approval by the regulatory agencies. These changes will be incorporated in the FY 2021 EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

The Energy Policy Act of 1992 provided for lease of the enrichment facilities to a commercial entity that operated the enrichment facilities from 1998 to 2013. In 2014, the leased facilities were returned to DOE control, and a DOE contractor began management of the facilities for DOE. These returned facilities are undergoing deactivation in preparation for decommissioning. DOE also is responsible for environmental remediation of the site. DOE is conducting environmental remediation activities under CERCLA. DOE also has oversight of the Depleted Uranium Hexafluoride (DUF_6) Conversion Facility, which converts cylinders of DUF_6 to a more stable form for reuse and/or disposal. Changes to the sampling programs reflected in the FY 2020 EMP include, but are not limited to, the following actions, which are described later in more detail.

- **Appendix B.** The annual synoptic water level event has been changed to quarterly in support of the Groundwater Strategy project and groundwater modeling at the site. The table containing water levels to support Water Policy Box evaluation has been removed. The required water levels now are incorporated into the "Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment," table.

- **C-400.** In support of the C-400 Remedial Investigation/Feasibility Study, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5 will be sampled quarterly for polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), along with the other routine, quarterly analytical parameters in FY 2020.

- **Water Policy Boundary Program.** As part of the Groundwater Strategy investigation and evaluation of the Water Policy Box, residential wells along Bethel Church Road and Ogden Landing Road will be evaluated to determine if they are able to be sampled. For those residential wells that are able to be sampled, samples will be collected for trichloroethene. In FY 2019, the analytical method for uranium isotopes was changed from alpha spectroscopy to inductively coupled plasma-mass spectroscopy in order to obtain a lower detection limit. This change is being reflected in this EMP.

- **Environmental Surveillance Groundwater Monitoring Program.** In support of groundwater modeling efforts at the site, McNairy monitoring wells (MWs) are being added to the semiannual sampling program. Most of these MWs have not been sampled in over 10 years. If they can be sampled, samples will be collected for volatiles, technetium-99, and uranium as a metal. MW356 is a McNairy MW and is being moved from the biennial sampling program to the semiannual sampling program. Sampling for perfluorinated chemicals has been removed because the sampling was completed in FY 2019.

- **Environmental Radiation Protection Program—Effluent and Surface Water Runoff. Surveillance Groundwater Monitoring Program.** The threshold limits for alpha activity and beta activity are being removed, and full isotopic analysis is being performed on all samples in order to evaluate low-level concentrations of radionuclides. This change is not due to any increasing trend, but to help in determining dose concentrations to the maximally exposed individual.

- **Environmental Surveillance Watershed Monitoring Program.** The threshold limits for alpha activity and beta activity are being removed, and full isotopic analysis is being performed on all samples in order to evaluate low level concentrations of radionuclides. This change is not due to any increasing trend, but to help in determining dose concentrations to the maximally exposed individual.

- **Ambient Air Monitoring.** Americium-241 and neptunium-237 were being analyzed by gamma spectroscopy. The method is being changed to alpha spectroscopy because it is the more sensitive method. The analytical method listed for americium-241 already reflects alpha spectroscopy, and the analytical method for neptunium-237 has been updated to alpha spectroscopy.

1. INTRODUCTION

1.1 PURPOSE

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2020 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance (QA) management. Guidance for EM is included in U.S. Department of Energy (DOE) Order (O) 436.1, *Departmental Sustainability*; DOE O 458.1, *Radiation Protection of the Public and the Environment*; DOE/HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015), hereinafter identified as the Radiological Guide; and Commonwealth of Kentucky and federal regulations that implement federal environmental laws. The purpose of the Radiological Guide is to identify procedures, systems, methods, instruments, and practices that may be used to plan and implement radiological effluent monitoring and environmental surveillance that meet the requirements in DOE O 458.1.

This FY 2020 EMP supports meeting requirements in DOE O 436.1 and DOE O 458.1 at the site. DOE O 436.1, Departmental Sustainability, requires that sites incorporate activities and programs to meet the goals of the Strategic Sustainability Performance Plan (SSPP), which are specified in Executive Order 13693. These environmental stewardship goals of the SSPP require sites to prevent pollution and eliminate waste; follow sustainable acquisition practices; encourage agency innovation; reduce greenhouse gas emissions; perform regional and local planning; execute and integrate high-performance sustainable design and green building best practices; and usher in electronic stewardship and data center energy efficiency. DOE O 458.1 establishes standards and requirements for DOE operations with respect to protection of the public and the environment against undue risk from radiation.

This EMP also supports permit requirements and supplements the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigations (RIs) being conducted at the Paducah Site under the Federal Facility Agreement (FFA) for the Paducah Gaseous Diffusion Plant (EPA 1998). In accordance with the Paducah Site Management Plan, the following CERCLA operable units (OUs) require investigation—C-400 Complex, surface water, groundwater, soils, burial grounds, decontamination and decommissioning, lagoons, soils and slabs, and depleted uranium hexafluoride (DUF_6) footprint underlying Soils OU that require investigation (DOE 2018b). This EMP is integrated with OU investigations and/or remedial actions to help provide collection of optimal data sets.

1.2 SCOPE

EM at the Paducah Site consists of effluent monitoring and environmental surveillance activities and supports the evaluation and assessment of unplanned releases. Monitoring is conducted routinely for a variety of media including air, surface water, groundwater, and sediment. Effluent monitoring is the direct measurement or the collection and analysis of liquid discharges and gaseous emissions to the environment. Environmental surveillance is the direct measurement or the collection and analysis of ambient air, surface water, groundwater, sediment, and other media.

In order for DOE and Four Rivers Nuclear Partnership, LLC, (FRNP) to comply with applicable environmental, public health, and resource protection requirements cost-effectively, the EMP is evaluated and modified, as appropriate. These modifications may include adjusting the number of monitoring wells

(MWs) that are sampled, changing sampling frequency of certain activities, or eliminating parameters to avoid duplication of data. As a contractor for DOE at the Paducah Site, FRNP evaluates optimization of sampling efforts in order to provide a comprehensive data set to the affected projects. Changes to the EMP, as a result of these evaluations, will be documented in the EMP rationale section and in each specific project section in Appendix C of the EMP. Changes that occur and are implemented during the FY will be documented in the following year's EMP. Optimization of permit-required sampling also is performed, but will be implemented only when approved by the regulatory agencies.

The Paducah Site EMP is evaluated and modified, as appropriate, using the data quality objective (DQO) methodology on an FY basis (i.e., October 1 through September 30) (EPA 2006). Measurement quality objectives are addressed in Appendix D, the "Environmental Monitoring Quality Assurance Project Plan" (QAPP), which is consistent with the Programmatic QAPP (DOE 2019b). Project data, following data verification, data assessment, and data validation, are placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS). Data loaded into Paducah OREIS then is available to public stakeholders via the Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS). Results are published and made available to the public in the form of the Annual Site Environmental Report (ASER).

QA is assured through assessments and management reviews. At a minimum, a management review of a sampling activity mandated by a permit will be conducted on a quarterly basis.

Operational sampling included in the Title V air permit is considered outside the scope of the EMP. FRNP will implement the appropriate operational sampling. While this EMP addresses liquid effluent monitoring from the DUF_6 conversion facility, which is operated by Mid-America Conversion Services, LLC, (MCS) this EMP does not address gaseous emissions monitoring that is conducted by MCS in support of their air permit.

1.3 RATIONALE

The rationale for EM activities at the Paducah Site for FY 2020 is premised by the understanding that sampling frequency, sampling parameters, and analytical methods must be sufficient to meet regulatory and contractual requirements and support appropriate DOE orders and guidance cost-effectively.

Data collected under existing permits, National Emission Standards for Hazardous Air Pollutants (NESHAP) Management Plan (FRNP 2018b), and under CERCLA or Resource Conservation and Recovery Act (RCRA) decision documents will continue to be evaluated in FY 2020. Sampling frequencies and sampling parameters that were modified for a sampling program that was permit-driven or collected as a result of a CERCLA or RCRA decision document were changed only if the permit or decision document allowed the change. If, during FY 2020, changes are deemed appropriate based on trending analyses, changes will be proposed via a permit modification or decision document change and implemented immediately after approval by the regulatory agencies. These changes will be incorporated in the FY 2021 Paducah Site EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

Changes to the sampling programs reflected in the FY 2020 EMP include, but are not limited to, the following actions, which are described in more detail in Appendix B and Appendix C.

- **Appendix B.** The annual synoptic water level event has been changed to quarterly in support of the Groundwater Strategy project and groundwater modeling at the site. The table containing water levels

to support Water Policy Box evaluation has been removed. The required water levels now are incorporated into the "Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment," table.

- **C-400.** In support of the C-400 Remedial Investigation/Feasibility Study, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5 will be sampled quarterly for PCBs and PAHs along with the other routine, quarterly analytical parameters in FY 2020.

- **Water Policy Boundary Program.** As part of the Groundwater Strategy investigation and evaluation of the Water Policy Box, residential wells along Bethel Church Road and Ogden Landing Road will be evaluated to determine if they are able to be sampled. For those residential wells that are able to be sampled, samples will be collected for trichloroethene (TCE). In FY 2019, the analytical method for uranium isotopes was changed from alpha spectroscopy to inductively coupled plasma-mass spectroscopy in order to obtain a lower detection limit. This change is being reflected in this EMP.

- **Environmental Surveillance Groundwater Monitoring Program.** In support of groundwater modeling efforts at the site, McNairy monitoring wells (MWs) are being added to the semiannual sampling program. Most of these MWs have not been sampled in over ten years. If they can be sampled, samples will be collected for volatiles, technetium-99, and uranium as a metal. MW356 is a McNairy MW and is being moved from the biennial sampling program to the semiannual sampling program. Sampling for perfluorinated chemicals has been removed because the sampling was completed in FY 2019.

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- **Environmental Surveillance Watershed Monitoring Program.** The threshold limits for alpha activity and beta activity are being removed, and full isotopic analysis is being performed on all samples in order to evaluate low-level concentrations of radionuclides. This change is not due to any increasing trend, but to help in determining dose concentrations to the maximally exposed individual.

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1.4 GENERAL CONSIDERATIONS

1.4.1 Site Description

The Paducah Site is located in a generally rural area of McCracken County, Kentucky [population approximately 65,000 (DOC 2019)]. Uranium enrichment ceased in May 2013. The uranium enrichment process facility consisted of a diffusion cascade and extensive support facilities. The cascade, including product and tails withdrawal, is housed in six large process buildings. The plant is located on a reservation consisting of approximately 3,556 acres in western McCracken County, 10 miles west of Paducah, Kentucky, [population approximately 25,000 (DOC 2019)] and 3.5 miles south of the Ohio River (Figure 1). DOE property has a heavily developed industrial area, with nonindustrial lands

around it. Approximately 1,986 acres of the nonindustrial land are licensed to the Commonwealth of Kentucky as part of WKWMA. The land licensed to Kentucky contains access roads and multiple rights-of-way for electrical transmission lines, but it is otherwise a mixture of woodlands and meadows.

The population within a 50-mile radius of the Paducah Site is about 534,000. Within a 10-mile radius of the Paducah Site, the population is approximately 87,750 (DOC 2019).

1.4.2 Site Background Information

Before World War II, the area now occupied by the Paducah Site was used for agricultural purposes. Numerous small farms produced various grain crops, provided pasture for livestock, and included large fruit orchards.

During World War II, a 16,126-acre tract was assembled for construction of Kentucky Ordnance Works, which subsequently was operated by the Atlas Powder Company until the end of the war. At that time, it was turned over to the Federal Farm Mortgage Corporation and then to the General Services Administration (GSA).

In 1950, the U.S. Department of Defense (DOD) and DOE's predecessor, the Atomic Energy Commission (AEC), began efforts to expand fissionable material production capacity. As part of this effort, the National Security Resources Board was instructed to designate power areas within a strategically safe area of the United States. Eight government-owned sites initially were selected as candidate areas. In October 1950, as a result of joint recommendations from DOD, U.S. Department of State, and AEC, President Harry S. Truman directed AEC to expand further production of atomic weapons. One of the principal facets of this expansion program was the provision for a new gaseous diffusion plant. On October 18, 1950, AEC approved the Paducah Site for uranium enrichment operations and formally requested the Department of the Army to transfer the site from GSA to AEC. Of the 7,566 acres acquired by the AEC, 1,361 acres subsequently were transferred to the Tennessee Valley Authority (Shawnee Fossil Plant Site), and approximately 2,700 acres were conveyed to the Commonwealth of Kentucky for wildlife conservation and for recreational purposes [West Kentucky Wildlife Management Area (WKWMA)].

Although construction of PGDP was not complete until 1954, production of enriched uranium began in 1952. Recycled uranium from nuclear reactors was introduced into the PGDP enrichment cascades in 1953 and continued through 1964. In 1964, cascade feed material was switched solely to virgin-mined uranium. Use of recycled uranium resumed in 1969 and continued through 1976. In 1976, the practice of recycling uranium feed material from nuclear reactors was halted and never resumed. During the recycling time periods, Paducah received approximately 100,000 metric tons of recycled uranium containing an estimated 328 grams of plutonium-239 (Pu-239), 18,400 grams of neptunium-237 (Np-237), and 661,000 grams of technetium-99 (Tc-99). The majority of the Pu-239 and Np-237 was separated out during the initial chemical conversion to uranium hexafluoride (UF_6). Concentrations of transuranics (e.g., Pu-239 and Np-237) and Tc-99 are believed to have been deposited on internal surfaces of process equipment and in waste products.

In October 1992, congressional passage of the 1992 National Energy Policy Act established USEC. USEC operated the uranium enrichment process until 2013, at which time USEC began transition of the facilities to DOE, as specified by the terms and conditions of the Lease Agreement.

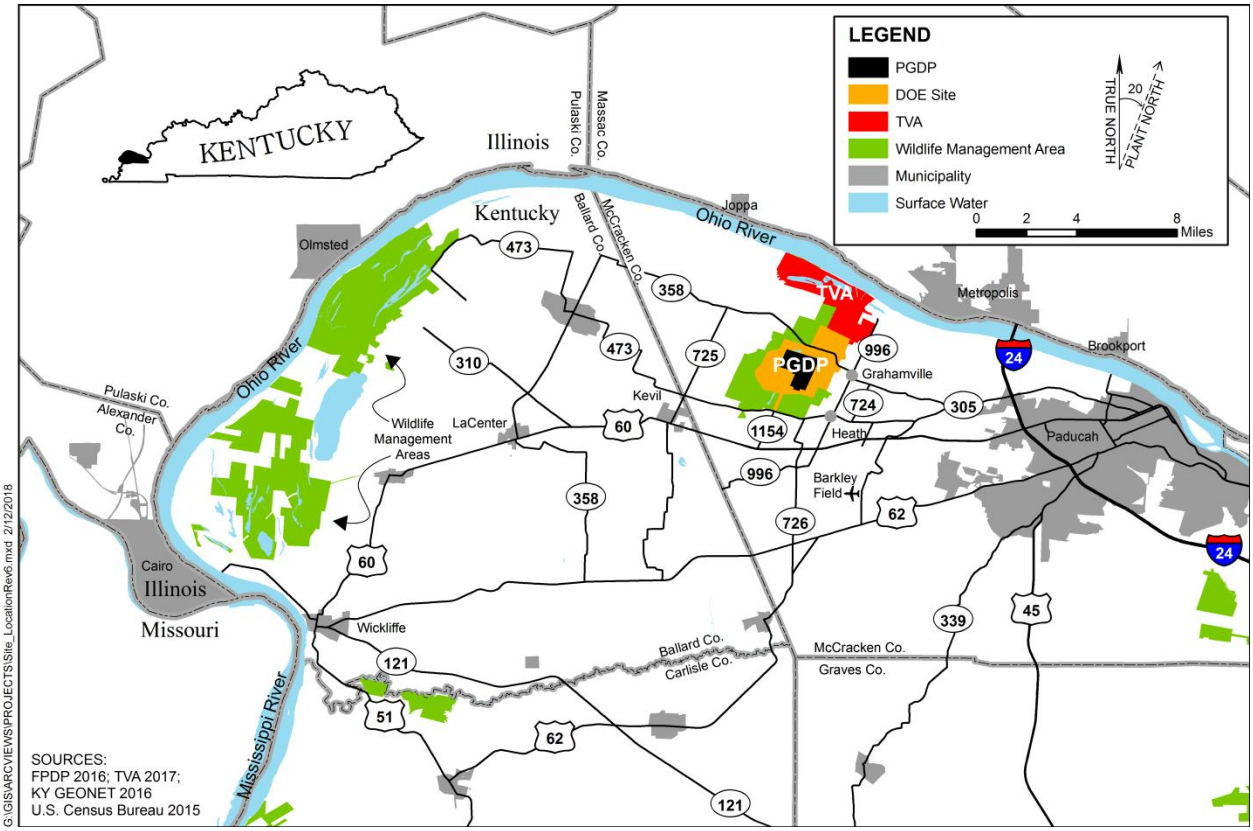

Figure 1. Location of the Paducah Site

PGDP was placed on the U.S. Environmental Protection Agency (EPA) National Priorities List on May 3, 1994, with an effective date of June 30, 1994. Environmental restoration is being addressed under an FFA with EPA and the Commonwealth of Kentucky (EPA 1998). The FFA became effective February 13, 1998.

1.5 PLAN OBJECTIVES

The following are the main objectives of this EMP.

- Ensure the early identification of potential adverse environmental impacts associated with DOE operations through effluent monitoring and environmental surveillance.

- Ensure that analytical work supporting EM is implemented using the following:

  — A consistent system for collecting, assessing, and documenting environmental data of known and documented quality;

  — A validated and consistent approach for sampling and analysis of samples to ensure laboratory data meet program-specific needs and requirements; and

  — An integrated sampling approach to avoid duplicative data collection.

- Support the "fully implemented status" of the Paducah Site Environmental Management System (EMS).
- Support the implementation of the Paducah Site Integrated Safety Management System (ISMS).
- Ensure integration of EMS into the site's ISMS.

Outputs from implementation of the EMP may be used to do the following:

- Provide data for use in the ASER, which informs the public about releases and potential impacts from DOE operations to human health and the environment;
- Identify DOE operations pollutant contributions;
- Provide ancillary data that may be required to assess the consequences of a spill or release;
- Identify significant changes in sample analytical results;
- Support or supplement data needs for CERCLA actions; and
- Provide a mechanism for long-term data collection needs under the FFA, when applicable.

1.6 PLAN OVERVIEW

Section 1 is used to describe the program's relevant historical and current information. Section 2 of this document describes effluent monitoring for liquid and airborne radiological constituents. Section 3 discusses meteorological monitoring, which is collected from the National Weather Service. Section 4 addresses, by media, environmental surveillance activities undertaken to monitor the radiological impacts of DOE operations. Section 5 describes the dose calculation methods used for the site. Section 6 provides various reporting requirements. Section 7 lists references utilized in the preparation of this plan.

The appendices provide detailed information regarding site permits, groundwater well information, sampling program details, QA, and data management.

1.7 MEASURING FACILITY IMPACT

The Radiological Guide requires comparisons of the measured concentrations against measured concentrations at "background" locations. For the purposes of this EMP, a "background" location also is called a reference location and is defined as an area unaffected by releases from the Paducah Site. The area could, however, be impacted by the operation of other industrial or commercial facilities. When no standards or criteria exist for contaminants that may have an impact on human health or the environment, comparisons to concentrations at reference locations can be made to determine if concentrations are significantly higher near the Paducah Site boundary.

2. EFFLUENT MONITORING

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and permit requirements. It also helps evaluate the effectiveness of effluent treatment and control; helps identify potential environmental problems and evaluate the need for remedial actions or mitigation measures; supports permit revision and/or reissuance; and detects, characterizes, and helps to report unplanned releases. Effluent monitoring is initiated to demonstrate compliance with one or more federal or Commonwealth of Kentucky regulations, permit conditions, or environmental commitments made in environmental impact statements, environmental assessments, DOE Orders and guides, or other official documents. Table 1 lists the various routine effluent monitoring activities performed at the Paducah Site. This table includes monitoring of liquid effluents, but it does not include gaseous effluents by MCS operations or FRNP. MCS and FRNP conduct gaseous emissions monitoring on their systems, as described in Section 1 of this EMP. Ambient air monitoring, which is required by NESHAP, is included within this EMP. A summary of permits and compliance agreements is included in Appendix A.

Table 1. Routine Liquid Effluent Monitoring

Program	Number of Locations	Sampling Frequency
Surface Water		
C-746-S&T Landfills	3[a]	Quarterly
C-746-U Landfill	3[a]	Quarterly
Environmental Radiation Protection Program (ERPP) near Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls	14	Monthly
KPDES[b]		
Outfall (K001)	1	Weekly
Outfall (K002, K004[c], K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, K020)	14	Monthly
Outfall Toxicity[d] (K001, K010, K011[e], K017)	4	Quarterly
CERCLA Outfall		
C001	1	Weekly and quarterly
Leachate		
C-746-S Landfill	1	As required and annually
C-746-U Landfill	1	As required and annually
C-404 Landfill	1	As required

[a] One location, L154, is cited in the Solid Waste Landfill Permit for both the C-746-S&T Landfills and for the C-746-U Landfill. L154 is included in the totals for both landfills. Total number of locations sampled equals five.
[b] Sampling frequency reflects most frequent analyses required by the permit and does not reflect field measurement analyses.
[c] K004 is sampled twice per month.
[d] K001, K010, and K011 are monitored for chronic toxicity. K017 is monitored for acute toxicity.
[e] Chronic toxicity is required only when the effluent from the C-617 Lagoon is discharged through the outfall.
NOTE: Sampling locations and frequencies are detailed in Appendix C.

The primary statute governing the monitoring of effluents to surface water is the Clean Water Act (with the exception of radionuclides), which requires the issuance of a National Pollutant Discharge Elimination

System (NPDES) permit.[1] EPA has delegated administration of the NPDES Program to the Kentucky Division of Water (KDOW) KPDES Program. The KPDES permit requires radiological monitoring at some of the permitted outfalls for reporting purposes only.

Sampling and analytical methods meet the requirements described in 40 *CFR* § 136 or the KPDES permit. In addition, DOE O 458.1, *Radiation Protection of the Public and the Environment,* and the Radiological Guide provide general and detailed guidance regarding the establishment of effluent monitoring programs for radiological parameters.

Rationale and Design Objectives. To ensure the protection of public health and the environment, the technical/regulatory objectives identified as part of DQOs for the Effluent Monitoring Program include the following:

- Verifying compliance with applicable federal, Commonwealth of Kentucky, and local effluent regulations and DOE Orders;
- Determining compliance with commitments made in environmental impact statements, environmental assessments, or other official documents;
- Evaluating the effectiveness of treatment processes and pollution control;
- Identifying potential environmental problems and evaluating the need for remedial actions or mitigating measures;
- Supporting permit revision and/or reissuance;
- Detecting, characterizing, and reporting unplanned releases; and
- Measuring changes in monitored concentrations of constituents in effluent over time.

In addition, Section 2.0 of the Radiological Guide recommends that this plan document the following:

- Effluent monitoring (sampling or *in situ* measurement) extraction locations used for providing quantitative effluent release data for each outfall;
- Procedures and equipment used to perform the extraction and measurement;
- Frequency and analyses required for each extraction (continuous monitoring and/or sampling) location;
- Method detection level (MDL)/minimum detectable activity (MDA) and accuracy by analyte;
- QA components; and
- Effluent outfall alarms (not required at the Paducah Site).

The preceding requirements are addressed as follows.

[1] Radioactive materials that are regulated under the Atomic Energy Act of 1954 are excluded from the Clean Water Act.

- Appendix C of this document lists all effluent monitoring locations. Appendix C specifies sampling and field measurements, as well as analytical method information. Appendix C also lists the sampling frequency at each location and the required analytical parameters and analytical methods. Additionally, Appendix C specifies the sampling driver for each sampling program (e.g., permit, CERCLA decision document). Generally, data collected as part of this document not only meets permit and CERCLA decision requirements, it also provides data sets that may be used in future CERCLA decision documents.

- Appendix D of this document provides the QAPP. All QA components are outlined within this plan. The QAPP identifies reporting limits [or practical quantification limits (PQLs)] and MDLs/MDAs. In cases where reporting limits (or PQLs) are specified under a given regulatory driver, those requirements are denoted as such within the QAPP.

- Each laboratory receives a statement of work for all sampling activities. The reporting limits (or PQLs) found in the QAPP are specified in the statement of work as a condition of work. If a laboratory cannot meet these limits, and if the limits are not a matter of regulatory compliance, the contractor project manager may approve the increased reporting limits (or PQL) and/or MDLs/MDAs.

- Monitoring results from the KPDES outfalls are summarized in the discharge monitoring reports, which are submitted on a monthly basis to the KDOW as required by the KPDES permit. Notifications of exceedances to the permit are submitted per the specifications within the permit. Surface water monitoring results at the landfills are summarized in quarterly reports and submitted to KDWM on a quarterly basis.

Evaluation of Effluents. Effluents, regardless of whether they contain radiological contaminants from new or modified facilities, are to be evaluated against permit conditions (as applicable) by the Environmental Compliance support personnel. Additionally, data are reviewed by the ERPP organization for evaluation and trending purposes and to determine any required response.

Physical/Chemical/KPDES. KPDES is the regulatory program administered by KDOW for discharge of wastewaters to the waters of the Commonwealth of Kentucky. The DOE Paducah Site KPDES permit, KY0004049, establishes monitoring requirements for the discharge of effluent and surface water runoff.

The permit defines limits on the concentration and amounts of specific chemicals that can be discharged and on the physical impact of those discharges (e.g., temperature or biological harm) to surface waters.

Processes for DOE operations have been evaluated to determine the chemicals, radiological components, and physical parameters (e.g., temperature) likely to affect the KPDES-permitted effluents. Effluents from permitted landfills are evaluated during the reporting and permit renewal processes.

Radiological. Based on the evaluation of emissions and the results of radiological monitoring from historical data sets, neither continuous monitoring nor continuous sampling with frequent analyses is required by DOE O 458.1. The KPDES permit requires radiological analyses at some of the outfall locations (Figure C.12).

Effluent sampling is required by the ERPP. Radiological data sets of effluent water near the KPDES outfalls (Figure C.13), along with surveillance data of surface water and sediments slightly downstream (Figures C.15 and C.16), are evaluated as part of the ERPP.

Program Implementation Procedures. The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP. In that role, the FRNP EM manager reports through a line organization to the Environmental Services Director and provides centralized coordination responsibilities.

2.1 LIQUID

2.1.1 Surface Water

Surface water leaving KPDES outfalls/the CERCLA outfall includes rainfall runoff from cylinder yards and landfills and effluent from site processes. The intent of monitoring is to assess compliance with Commonwealth of Kentucky and federal regulations, permits, and DOE Orders and to assess the impact of DOE operations on the local environment.

C-746-S&T and C-746-U Landfills Surface Water. Rainfall runoff from three locations at C-746-U Landfill and three locations at C-746-S&T Landfills (Figure C.11) are sampled quarterly for parameters listed in Appendix C. Although three locations are cited for each, there are only five unique locations.

KPDES Monitoring. Fifteen effluent sampling points covered by the KPDES permit are illustrated in Appendix C (Figure C.12).

2.1.2 Leachate

C-746-S and C-746-U Landfills Leachate. Untreated leachate from the solid waste landfills is sampled annually and is analyzed for the parameters listed in Appendix C in accordance with permit requirements.

C-404 Landfill Leachate. Leachate samples are collected from the C-404 Landfill Leachate Collection System and analyzed for the parameters listed in Appendix C in accordance with permit requirements.

2.2 AIRBORNE

Airborne emissions are regulated by the Kentucky Division for Air Quality. For emissions that may be harmful to the public or the environment, permits are required from the Division for Air Quality. Operations at the Paducah Site require air permits. Ambient air monitoring, which monitors fugitive emissions from all Paducah Site operations, is conducted by eight continuous air monitors, as described in the approved Paducah Site NESHAP Management Plan, CP2-EC-0002 (FRNP 2018b). Data from a background location also is collected.

Operational sampling included in the Title V air permit (V-14-012) is considered outside the scope of the EMP. FRNP will implement the appropriate operational sampling included in the Title V air permit (V-14-012). This data will be available in the event it is needed to evaluate site conditions; however, this sampling is considered outside the scope of the EMP. Additionally, the DUF_6 facility maintains a Conditional Major, Operating permit (F-15-042), which also is considered outside the scope of the EMP.

3. METEOROLOGICAL MONITORING

DOE operations may have airborne radionuclide and chemical emissions from various sources, such as CERCLA remedial actions, as well as fugitive emissions and stack emissions from deactivation of the gaseous diffusion buildings. The Paducah Site requires meteorological monitoring data to support both chemical and radiological evaluations. The Radiological Guide recommends that a meteorological monitoring program appropriate to site activities be established. The Paducah Site no longer operates the on-site meteorological tower to collect meteorological data. Meteorological data sets purchased from other sources and historical data collected at the site may be used to model the radiological and chemical emissions. Purchased meteorological data is procured from accredited meteorological measuring stations that are in close proximity to the site.

3.1 CHEMICAL EMISSIONS

DOE operations may have airborne chemical emissions from various sources, such as CERCLA remedial actions, as well as fugitive emissions.

3.2 RADIOLOGICAL EMISSIONS

Operations at the Paducah Site may have airborne radiological emissions from various sources, such as CERCLA remedial actions, deactivation activities, DUF_6 conversion activities, as well as fugitive emissions. Modeling to demonstrate compliance with NESHAP regulations is conducted using the Clean Air Act Assessment Package-88 (CAP-88). In accordance with the NESHAP Management Plan (FRNP 2018b), meteorological data utilized for CAP-88 are compiled from the National Weather Service at Paducah and the National Climatic Data Center's "Climate at a Glance" database. Other dose modeling software such as RESRAD-OFFSITE or RESRAD-BIOTA may be used with appropriate meteorological data sets.

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4. ENVIRONMENTAL SURVEILLANCE

Supporting the goal of DOE O 436.1, *Departmental Sustainability*, for planning environmental activities, the Paducah Site performs environmental surveillance. Environmental surveillance is the collection and analysis of samples or direct measurements of air, water, sediment, and other media from DOE sites and their environs for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment; therefore, the environmental surveillance program is a comprehensive environmental program addressing radiological and nonradiological parameters.

In support of DOE O 458.1, *Radiation Protection of the Public and the Environment*, the Paducah Site performs monitoring of remedial actions and activities to monitor that members of the public are not exposed to ionizing radiation at a total effective dose (TED) exceeding 100 mrem (1 mSv) in a year from all site-related sources of ionizing radiation and exposure pathways. Air emissions are covered under 40 *CFR* § 61, NESHAP. Under 40 *CFR* § 61.92, emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem per year.

DOE activities must be conducted to ensure that radionuclides contained in liquid effluents do not cause private or community drinking water systems to exceed an annual dose of 4 mrem per year per 40 *CFR* § 141, which is more limiting than DOE O 458.1 limit of 10 mrem per year. For monitoring of community drinking water systems, 40 *CFR* § 141 allows for environmental surveillance data to be used in the vicinity of nuclear facilities. The nearest downstream community water withdrawal location is Cairo, Illinois, located on the Ohio River. For comparison purposes, a background sample of the Ohio River water is collected upstream of the site. The plant effluent sampling results are evaluated against both the Cairo, Illinois, sampling results and the background location sampling results. This evaluation is to demonstrate that plant effluent concentrations are below a 4 mrem per year standard at the community drinking water system. Plant environmental surveillance sampling locations are within the Bayou and Little Bayou Creek systems prior to confluence with the Ohio River.

DOE O 458.1 defines “public dose” as the dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE radiological activity whether the exposure is within a DOE site boundary or off-site. It does not include doses received from radon and its decay products in air (regulated separately under DOE O 458.1), occupational exposures, doses received from naturally occurring “reference” radiation, or doses received by a patient from medical procedures. The determination of the public dose, as established by EPA regulation 40 *CFR* § 61, differs in that the 10 mrem EDE per year limit applies to dose received where the members of the public reside.

The Radiological Guide recommends that DOE facilities perform routine surveillance if an annual dose of site origin at the site boundary exceeds either 5 mrem per year ED to an individual or 100 person-rem collective ED within a radius of 80 km (about 50 miles) of a central point on the site. Historically, as reported in previous ASERs, the annual dose due to DOE operations at the Paducah Site has been less than 5 mrem per year ED (individual) or 100 person-rem collective ED.

An overview of routine environmental surveillance is provided in Table 2, which lists for each program the number of sampling locations, sampling frequency, sample type, and parameters for the analysis performed.

Table 2. Routine Environmental Surveillance

Program	Number of Locations	Sampling Frequency	Sample Type	Parameters
Groundwater				
Surveillance	30	Annually	Grab	See Appendix C
Surveillance	83	Biennially (Sampled FY 2019—will be sampled in FY 2021)	Grab	See Appendix C
Surveillance	14	Semiannually	Grab	See Appendix C
Surveillance	3	Quarterly	Grab	See Appendix C
Surveillance Geochemical	37	Every 3 years (Sampled FY 2019—will be sampled in FY 2022)	Grab	See Appendix C
C-746-S&T Landfills	25[a]	Quarterly	Grab	See Appendix C
C-746-U Landfill	21[a]	Quarterly	Grab	See Appendix C
C-404 Landfill	9	Semiannually	Grab	See Appendix C
C-746-K Landfill	3	Semiannually	Grab	See Appendix C
Northeast Plume	36	Quarterly	Grab	See Appendix C
Northwest Plume	32	Semiannually	Grab	See Appendix C
Northwest Plume	1	Quarterly	Grab	See Appendix C
C-400	11	Quarterly	Grab	See Appendix C
C-400	8	Semiannually	Grab	See Appendix C
SWMU 1	7	Semiannually	Grab	See Appendix C
Water Policy Boundary—NW	30	Quarterly	Grab	See Appendix C
Water Policy Boundary—NE	7	Annually	Grab	See Appendix C
Residential Carbon Filter System	1	Semiannually	Grab	See Appendix C
Surface Water and Seeps				
Surface Water and Seeps	3	Quarterly	Grab	See Appendix C
Surface Water—ERPP	7/2	Quarterly/Annually	Grab	See Appendix C
C-613 Sediment Basin	1	Quarterly	Grab	See Appendix C
KPDES[b]				
Outfall (K001)	1	Weekly	Grab	See Appendix C
Outfall (K002, K004[c], K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, K020)	14	Monthly	Grab	See Appendix C
Outfall Toxicity[d] (K001, K010, K011[e], K017)	4	Quarterly	Composite and Grab[d]	See Appendix C
Sediment				
Sediment	14	Semiannually	Grab	See Appendix C
Sediment—ERPP	6	Annually	Grab	See Appendix C
Ambient Air	9	Weekly/Quarterly	N/A	See Appendix C
Meteorologic[f]	N/A	N/A	N/A	N/A

Table 2. Routine Environmental Surveillance (Continued)

Program	Number of Locations	Sampling Frequency	Sample Type	Parameters
Environmental Dosimeters	64/7	Quarterly	Continuous	External Gamma/Neutron

[a] Four of the same wells are cited in the Solid Waste Landfill Permit for C-746-S&T and C-746-U Landfills. For these totals, the wells are counted for both programs. Also, for the C-746-S&T Landfills locations, the count of 25 wells includes 2 wells that are measured only for water level. Twenty-three locations are sampled for analytical laboratory parameters.
[b] Sampling frequency reflects most frequent analyses required by the permit and does not reflect field measurement analyses.
[c] K004 is sampled twice per month.
[d] K001, K010, and K011 are monitored for chronic toxicity. K017 is monitored for acute toxicity.
[e] Chronic toxicity is required only when the effluent from the C-617 Lagoon is discharged through the outfall.
[f] Information is taken from the National Weather Service and historic data sets.

4.1 GROUNDWATER

4.1.1 Introduction

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies within the northern tip of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediment unconformably overlying Paleozoic bedrock. The *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992) discusses geology and hydrogeology of the Paducah Site in detail. Additional information regarding the geology and hydrogeology at the Paducah Site is covered in the *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (DOE 2017b) for the Paducah Site. The most recent groundwater contaminant plume maps were developed in 2019 and are contained in *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2018 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (FRNP 2019).

An investigation is being performed under the Groundwater Strategy project to evaluate the extent of TCE and groundwater flow trends at the site. Manual water level measurements and measurements of data loggers/pressure transducers along with implementing colloidal borescopes will be used to measure the potentiometric surface and seasonal changes in the potentiometric surface. MWs planned under this project are included in Appendix B.

The annual synoptic water level event is being changed to quarterly to support the Groundwater Strategy project and groundwater modeling. Also in support of the Groundwater Strategy project and groundwater modeling, during the quarterly synoptic water level events, water level elevation at Metropolis Lake will be measured. A survey control point has been established near the lake.

4.1.2 Rationale and Design Criteria

The groundwater monitoring program consists of routine compliance monitoring designed to ensure the protection of public health and the environment. The technical criteria identified as part of DQOs for the groundwater monitoring program include the following:

- Obtain data to determine baseline conditions of groundwater quality and quantity;
- Demonstrate compliance with and implementation of all applicable regulations and DOE Orders;
- Provide data to allow early detection of groundwater pollution or contamination;

- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources; and

- Provide data for making decisions about waste disposal on land-based units and the management and protection of groundwater resources.

The following addresses specific laws, regulations, and orders.

DOE Orders. Neither DOE Orders nor the Radiological Guide requires specific groundwater sampling frequencies or parameters. Instead, DOE Orders require that sample collection programs reflect specific facility needs. Type and frequency of sampling shall be adequate to characterize effluent streams and to identify existing and potential groundwater contamination sources. Monitoring verifies that releases are stable without causing environmental harm. This EMP was written to include effluent monitoring and environmental surveillance at the Paducah Site. In order to provide a data set that is assessed for potential environmental impacts, a comparison data set from samples collected from areas that are not impacted by site operations also is required. Such sample locations are called "background" locations.

Commonwealth of Kentucky Regulation. Preparation of a Groundwater Protection Plan that addresses requirements to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution is required by 401 *KAR* 5:037. This requirement was addressed by DOE, by writing and implementing the Groundwater Protection Plan, according to 401 *KAR* 5:037, prior to the deadline of August 24, 1995. The current Groundwater Protection Plan is *Groundwater Protection Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-PROJ-0018/FR2 (FRNP 2018a). This document is reviewed and revised, as needed, to reflect current site operations.

Agreement in Principle Sampling. The Agreement in Principle (AIP) provides sampling and inspection of the differing monitoring programs. The oversight includes inspections (including MW inspections and surface water area inspections), sample analysis, statistical analysis of sample results, and data quality. KDWM AIP personnel conduct independent groundwater and surface water sampling and obtain DOE sample splits.

AIP personnel also respond to questions and concerns from the public, including sampling of residential wells. The AIP personnel participate in public meetings to provide an independent view of the effect of the Paducah Site on the local environment and health of the public.

CERCLA Actions. A requirement of the FFA is to determine the nature and extent of off-site contamination (attributed to historical releases from Paducah facilities). This requirement is addressed through the RI process and ongoing remedial actions for OUs at the Paducah Site, as well as for the sampling under this EMP. Ongoing remedial actions at the Paducah Site include the following.

The *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant* (Water Policy) (DOE 1994) stipulated the need to ensure that residential landowners whose well water was contaminated by PGDP sources were provided with water (DOE 1993a; DOE 1993b). The Water Policy was established in accordance with the Administrative Consent Order, following an Engineering Evaluation/Cost Analysis, and was written to document the preferred alternative addressing the need for protection of human health due to the presence of groundwater contamination originating from the Paducah Site. As soon as possible after contamination was found in local residential water supply wells, the affected households were supplied with bottled water. Construction of water mains allowed access to water lines for homes in the affected area. This was accomplished as a non-time-critical removal action under CERCLA. The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the Sampling and Analysis Plan Addendum, which was

superseded by the EMP. Currently, 27 wells are sampled in support of action (Figures C.8 and C.9). DOE also is planning to sample 10 additional residential wells along Bethel Church Road and Ogden Landing Road northwest of the Paducah site in support of the Groundwater Strategy project and Water Policy Box evaluation (Figure C.8).

Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building (DOE 2005) requires MW sampling. This sampling provides a meaningful tool for evaluating the downgradient dissolved-phase contamination in the Northwest Plume and the efficacy of the C-400 Interim Remedial Action (Figure C.6).

Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant[2] requires well sampling in order to monitor the nature and extent of groundwater contamination and to evaluate any cyclic trends in water quality that may affect contaminant migration (DOE 2010). There are 32 wells required to be sampled semiannually for the Northwest Plume (Figure C.5). In addition, one well will be sampled quarterly in order to evaluate trends in TCE concentrations along the Northwest Plume.

Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant[2] (DOE 2017a), and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant* (DOE 2018a), require quarterly sampling of 36 wells for the Northeast Plume (Figure C.4). The Northeast Plume O&M plan requires semiannual sampling of MW255 and MW256; however, these wells are sampled quarterly to provide timely assessment of Northeast Plume optimized extraction well operations. The Northeast Plume O&M plan requires sampling of a CERCLA outfall in order to monitor effluent from the Northeast Plume Containment System (DOE 2018a). The sampling requirements for the CERCLA outfall are included in this EMP.

Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) (DOE 2014) requires sampling of MWs in order to monitor the progress of contaminant reduction in the Regional Gravel Aquifer groundwater following soil mixing. Seven wells will be sampled semiannually in FY 2020 (Figure C.7).

4.1.2.1 Landfill groundwater monitoring program

C-746-S and C-746-T Landfills. C-746-S and C-746-T Solid Waste Landfills are closed landfills owned by DOE. These landfills currently are in postclosure status under the landfill permit. The groundwater is monitored utilizing a total of 25 MWs near the two landfills (Figure C.1). Of these 25, 23 are used for collection of samples to analyze organic, inorganic, and radiological parameters. The remaining two are used for water level measurements. Additional analytical information is found in Appendix C.

C-746-U Landfill. The C-746-U Solid Waste Landfill is an operating landfill owned and managed by DOE. This landfill currently is being operated as a contained landfill under the landfill permit; 21 MWs (Figure C.1) are monitored quarterly for organic, inorganic, and radiological parameters. Additional analytical information is found in Appendix C. Sampling and monitoring of the treatment system is not captured within this document because it is part of the daily operations of the landfill.

The sample collection order is as follows: volatiles (including total organic halides), dissolved gases and total organic carbon, semivolatile organics, metals and cyanide, water quality cations and anions, and

[2] O&M Plans also specify production sampling. Sampling and monitoring of treatment systems are not captured within this EMP.

radionuclides. If samples are being collected at a location where it is anticipated that sample volume is not adequate, then the order of collection will be volatiles followed by radionuclides.

C-404 Landfill. The C-404 Hazardous Waste Landfill is currently subject to post-closure monitoring under Hazardous Waste Management Facility Permit KY8-890-008-982. The C-404 Hazardous Waste Landfill currently is being monitored under detection monitoring (semiannual sampling) according to permit requirements, including Attachment E of the permit, "Groundwater Monitoring." The groundwater is monitored utilizing nine MWs (Figure C.2). There are six downgradient and three upgradient compliance point wells. Per the permit, sample aliquots shall be withdrawn in the following order: volatiles, total metals, and radionuclides. Remaining permit requirements may follow the radionuclide sample collection. Samples are to be collected twice a year: January through March as one sampling event and July through September as the second event. Results from the January through March event are reported to KDWM by May 30 and results from the July through September event are reported to KDWM by November 30.

Prior to sample collection, KDWM shall be notified one week in advance. Notification may be made in writing or electronic format. Electronic mail shall be submitted to pertinent KDWM field personnel.

All groundwater wells (MWs, piezometers, etc.) will be inspected annually during the third quarter of the calendar year (CY). The wells will be inspected for the condition of the Kentucky Groundwater Data Repository identification, the outer casing, the concrete pad, the bumper posts, painting, the well cap, the lettering and numbers, lock and hasp, well access, vegetation control, and well fittings and tubing. Items will be repaired, as necessary. The wells will be inspected annually for excessive sedimentation by performing a depth sounding at each MW. If a well is found that no longer meets the requirements of 401 *KAR* 34:060, the well will be abandoned in accordance with 401 *KAR* 6:350 and the Hazardous Waste Management Facility Permit. If a replacement well is needed, it will be installed in accordance with 401 *KAR* 6:350 and the requirements of the Hazardous Waste Management Facility Permit. In FY 2019, MW84, MW85, and MW93 were abandoned and replaced due to integrity issues with the wells.

C-746-K Landfill. Sampling of three MWs (Figure C.3) is conducted to evaluate the potential impact of historical waste disposal activities at the C-746-K Landfill on the groundwater quality parameters, which are analyzed semiannually, as identified in Appendix C. The Record of Decision (ROD) for Waste Area Groups 1 and 7 (DOE 1998) discussed sampling that was being conducted at the time of the ROD development; however, the ROD allowed for modifications to the sampling strategy with documentation of the strategy in a Sampling and Analysis Plan addendum, which was replaced by the EMP. Sampling of these wells is not required by a permit, but is conducted in support of the FFA CERCLA investigation and RCRA facility investigations according to the FFA. Additional analytical information is found in Appendix C.

4.1.2.2 Surveillance monitoring program

Environmental Surveillance Program. In order to monitor the nature and extent of groundwater contamination and to monitor groundwater quality, 82 nonbackground MWs and 1 background are sampled biennially, 29 nonbackground MWs and 1 background are monitored annually, 14 MWs are sampled semiannually, and 3 MWs are sampled quarterly, as shown in (Figure C.10). Sampling of these MWs is not driven by a permitted process, but is conducted in support of the FFA CERCLA investigations, as well as DOE O 436.1. The inclusion of these MWs in this program does not exclude them from other sampling programs. For ease of review, Appendix B of this document contains a well inventory list, which acts as a crosswalk for each MW and sampling program.

The sampling frequency for this program was modified in the FY 2011 EMP. The sampling frequency was modified from a quarter/semiannual basis to an annual/biennial basis. This modification was justified by an evaluation of the data collected over 10 years, which showed that there had not been significant changes that merited the need for sampling as frequently. The MWs that were selected to be monitored annually were selected based on their location within the plumes. The 82 MWs that were selected to be monitored biennially were sampled in FY 2019; therefore, these wells will not be sampled in FY 2020.

One background well is sampled biennially and one annually to monitor the background water chemistry of wells located upgradient of the plant to compare with MWs potentially impacted from plant activities.

MW152 was abandoned in October 2018 to enable Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583, and it will be included in the annual group of MWs once it has been installed.

In FY 2019, MW315 and MW330 were sampled for certain per-and polyfluoroalkyl substances at the Fire Training Area (Solid Waste Management Unit 100). Results from this sampling should be reported in PEGASIS by March 31, 2020; reported in a letter from the DOE Site Lead to EPA and the Kentucky Department for Environmental Protection by April 30, 2020; and reported in the 2019 ASER (which will be available to the public and the regulatory agencies in fall of 2020).

Environmental Surveillance (Geochemical Monitoring) Program. In order to monitor the effects of natural attenuation of groundwater contamination and to monitor groundwater quality, 37 MWs are to be sampled every 3 years (Table C.22). Sampling of these wells is not driven by a permitted process, but is conducted in support of the FFA CERCLA investigations, as well as DOE O 436.1. The sampling frequency for this program was modified in the FY 2011 EMP. The sampling frequency was modified from an annual basis to a triennial basis. These MWs were sampled in FY 2019 as part of the triennial basis sampling strategy; therefore, these wells will not be sampled in FY 2020.

4.1.3 Extent and Frequency of Monitoring

Appendix B provides information for all wells used at the Paducah Site, as well as residential wells located off-site. The groundwater sampling frequency and parameters, which are identified in Appendix C, are reviewed annually. The information detailed in Appendix C is the planning document for all monitoring and lists sites to be monitored, the governing program(s), MWs, parameters, analytical methods, and the sampling frequency.

4.1.4 Program Implementation Procedures

Organization. The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP.

Plans. The *Groundwater Protection Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* PAD-PROJ-0018/FR2, addresses the following specific requirements listed in Section 3(3) of 401 *KAR* 5:037 (FRNP 2018a):

(a) General information regarding the facility and its operation;

(b) Identification of activities associated with the facility, as identified in Section 2 of the regulation;

(c) Identification of all practices chosen for the plan to protect groundwater from pollution;

(d) Implementation schedules for the protection practices;

(e) Description of and implementation schedule for employee training necessary to ensure implementation of the plan;

(f) Schedule of required inspections, as applicable; and

(g) Certification of the plan by the appropriate Paducah Site representative.

These plans and the EMP provide the framework of the Groundwater Monitoring Program.

4.2 SURFACE WATER/SEDIMENT ENVIRONMENT

Surface Water. Measurement of water quality parameters in surface water samples provides a general guide to the environmental health of the system. Certain contaminants (e.g., volatile organic compounds) that are not particularly concentrated in other media are more efficiently analyzed in water samples.

Sediment. A single sediment sample can represent information that would require a large number of water samples, spaced over a period of time, to reconstruct. Sediment acts to collect, concentrate, and store specific kinds of contaminants at specific locations. Concentrations of contaminants in sediments represent integrated measures of aqueous contaminant concentrations over some preceding period of time.

The Environmental Surveillance Program at the Paducah Site for surface water and sediment evolved over a number of years in response to regulatory and community concerns. Initially, the prudent action was to sample surface water at the permitted outfalls and upstream and downstream within the receiving streams to assess potential impacts. Since that time, DOE has conducted remediation/removal efforts at the site, which has decreased the potential for surface water and sediment contamination. Additionally, the effluent and surface water runoff from outfalls leaving the plant site is monitored to confirm no current impacts from ongoing operations. Monitoring at the outfalls is permitted by KDOW through the KPDES permit and radiological parameters are monitored under DOE O 458.1 requirements. Limited radiological samples for surface water and sediment are collected in the environment to verify the effectiveness of the outfall sampling and to evaluate the accumulation of radionuclides in the environment.

4.2.1 Rationale and Design Criteria

The surface water and sediment sampling sites included in this EMP are located on selected receiving streams downstream from primary contaminant sources and reference streams. The reference streams are located either off-site or on-site, but upstream of contaminant sources. Sample sites were selected to prioritize areas where the public had access and to capture any and all emissions from the plant site. Contaminant sources include both point sources (e.g., effluent outfalls) and nonpoint sources, such as waste disposal areas or burial grounds.

4.2.2 Extent and Frequency of Monitoring

4.2.2.1 Surface water program

Previously, the KPDES permit required sampling for PCBs and TCE at 19 locations upstream and downstream from Paducah Site operations. The current KPDES permit does not require this sampling; therefore, these locations were removed from this program in FY 2018, with the exception of the C-746-K

Landfill locations. The C-746-K Landfill locations will be sampled per the ROD for Waste Area Groups 1 and 7 (DOE 1998). One seep location in Little Bayou Creek is sampled quarterly for TCE (Figure C.15).

For radiological parameters, surface water is sampled quarterly at seven locations and annually at two locations. Two locations, L1 (background) and L30 (a location just downstream of the Paducah Site), are sampled annually. L29A (background) and a location near the nearest public water withdrawal location, Cairo, Illinois, (L306) are sampled quarterly. This sampling is performed to evaluate all potential radiological effluents leaving the site and to evaluate the effectiveness of the outfall sampling program. This supports the implementation of DOE O 458.1 through the ERPP, CP2-ES-0103 (FRNP 2018c). Additional analytical information is found in Appendix C.

4.2.2.2 Sediment program

Sediment samples are collected semiannually from 14 locations, 2 of which are considered background locations (Figure C.16). Five locations and a background are sampled for radiological parameters to evaluate the effectiveness of the plant effluent monitoring and to monitor the accumulation of contaminants in the environment. Sediment is sampled near the surface water and biological stations at locations downstream from plant operations and in background (reference) streams. Station locations coincide with those for surface water in Bayou Creek and Little Bayou Creek. Of note: Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise. Additional analytical information is found in Appendix C. An assessment code of "DRY" has been added in OREIS with the description of "Result reported on a dry weight basis," for data generated starting in FY 2014, as applicable.

4.2.3 Program Implementation Procedures

The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP. In that role, the FRNP EM manager reports through a line organization to the Environmental Services Director and provides centralized coordination responsibilities.

4.3 TERRESTRIAL ENVIRONMENT

Woodlands, meadows, and cultivated fields dominate the rural landscape around the DOE Reservation. Immediately adjacent to the DOE Reservation is WKWMA, which is used by a considerable number of hunters, trappers, and anglers each year. Hunting and trapping activities may include such wildlife as rabbit, deer, quail, raccoon, squirrel, dove, turkey, waterfowl, and beaver. Additionally, the Kentucky Department of Fish and Wildlife Resources sponsors field hunting trials for dogs within the WKWMA.

This section discusses the terrestrial environment near the Paducah Site that could become radiologically contaminated as a result of releases of materials from current or past DOE operations. Farm-raised animal products, as well as local wildlife in the area, may be contaminated through water releases. Wildlife and animal products, including meat, eggs, and milk, may become contaminated through animal ingestion of contaminated water, sediment, other animals, or through direct contact with contaminated areas. The subsequent ingestion of these products can lead to a dose to man and is discussed in subsequent sections. Concentrations of both radionuclide and chemical contaminants are evaluated in the terrestrial environment. The Radiological Guide suggests that if wild game, such as deer or game birds, is available locally, these species should be considered for radiological sampling purposes. Due to downward trends and continued lack of detectable results, this sampling is not performed. Additional details of these evaluations are discussed below.

4.3.1 Rationale and Design Criteria

AIRDOS-EPA computer code contained in the latest version of the CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by EPA's version of the DARTAB computer code to calculate radiation doses to the public from radionuclides released during the year.

4.3.1.1 Soils

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). See Section 4.3.1 for air modeling information.

4.3.1.2 Animal products

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.3.1.3 Food crops and vegetation

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops and vegetation where they may be absorbed into food crops and vegetation. These food crops then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.3.1.4 Wildlife

Wildlife monitoring (i.e., deer) historically was conducted near the Paducah Site. In 2011, an extensive review was conducted of data sets from 20 years of deer harvesting events. As a result of this review, the deer monitoring was eliminated because of a downward trend and a continued lack of detection in the results, as well as an overall downward trend in the concentration of contaminants found at the Paducah Site due to remediation efforts.

4.4 EXTERNAL RADIATION

The Paducah Site conducts routine surveillance of external gamma and neutron radiation exposure to monitor any effects due to past releases of radionuclides and current operations involving radioactive

sources (e.g., depleted uranium hexafluoride cylinder management). Historical monitoring has shown that the external gamma and neutron radiation dose from routine DOE operations at the Paducah Site boundary is under 10 mrem per year ED (individual) and 100 person-rem per year ED (collective dose for exposed population). Routine surveillance of external gamma radiation with dosimeters is conducted to provide data to model direct external radiation from sources located on-site consistent with DOE O 458.1. Area gamma and neutron dosimetry monitoring near cylinder yards has been in place in previous years to meet 10 *CFR* § 835 requirements.

4.4.1 Objectives

A primary objective is to calculate the ED of the MEI member of the public.

A second objective is to calculate ED to a member of the public in areas freely accessible to members of the public. The Paducah Site licenses a portion of the DOE Reservation to the Kentucky Department of Fish and Wildlife for recreational uses. These areas are open to the public for use but do not have any residences within the Paducah Site boundary. Public traffic is allowed on the main reservation roads outside of the active plant area as a courtesy to the public, and some members of the public visit the DOE Reservation for various reasons, including hunting. It is anticipated that any use would be limited to recreational purposes and durations of time spent in the area by the public would be less than full time.

A third objective is to calculate the ED to a member of the public at the Paducah Site boundary. No residences are on-site and any residential receptor would be beyond the Paducah Site boundary.

A fourth objective is to establish the potential dose that a member of the public may receive while visiting or passing through the Paducah Site. This would be for visitors accessing the Paducah Site in the area closed for public access but outside DOE-controlled areas, as defined by DOE O 458.1.

A fifth objective of external exposure monitoring is to establish the potential radiation dose from direct exposure to DOE operations at the boundary of the DOE perimeter fence.

4.4.2 Rationale and Design Criteria

The External Radiation Monitoring Program is designed to provide exposure data on direct radiation from DOE operations to members of the public. The primary factor in selecting the monitoring locations is the potential for a member of the public to be exposed to direct radiation. The highest potential radiation exposure to the public is at the plant perimeter.

The monitoring program conducts area external radiation dose monitoring using dosimeters. Devices of this type are capable of measuring exposure resulting from gamma and neutron radiation and are used throughout the industry to perform EM.

The primary sources for radiation exposure to areas outside the Paducah Site security fence are the UF_6 cylinder storage yards, which are located within the secured area, but in close proximity to the perimeter fence. Studies conducted within the cylinder storage yards have shown that the cylinders are sources of both gamma and neutron radiation. The neutrons are produced at moderate energy levels by the alpha-fluorine reaction taking place within the residual UF_6 material. Further studies have indicated that the range of the neutrons is such that the neutron dose rate falls off rapidly with distance.

4.4.3 Extent and Frequency of Monitoring

The extent and frequency of monitoring for external gamma radiation are determined based on the principle that the exposure levels decrease with distance from the sources and that the levels are relatively constant over time.

Public access assumptions are that (1) the security fence for the secured area provides a physical boundary beyond which the public has no access; (2) the locations of residences and communities outside the reservation are known; and (3) individual exposure scenarios may vary.

Environmental gamma detection dosimeters are located at 64 locations and neutron dosimeters are located at 7 locations, including inside the Paducah Site security fence, Paducah Site perimeter, outfalls, ditches, and background locations (Figure C.17). Dosimeters also have been placed in areas that historically have received the highest radiation exposure.

Data comparisons are made yearly between the current year and the prior year's radiation monitoring and the results are presented in the Annual Report on External Radiation Monitoring, as well as in the ASER.

4.5 AMBIENT AIR

DOE complies with 40 *CFR* Part 61, Subpart H, to control airborne emissions of radionuclides. This compliance includes evaluation of activities that have potential radionuclide emissions. The EDE from point sources is calculated based on monitoring information for each source.

In addition to point sources, DOE has identified potential fugitive and diffuse sources of radionuclides. In accordance with the Paducah Site NESHAP Management Plan, CP2-EC-0002, ambient air is monitored to measure concentrations of radionuclides from all sources, including fugitive and diffuse (FRNP 2018b). The ambient air monitoring network is comprised of nine air monitoring stations surrounding the site, including one background station (Figure C.18). Additional analytical information is found in Appendix C.

Because the public dose has been below 10 mrem per year consistently, additional sampling beyond the ambient air monitoring is not warranted for the FY 2020 EMP.

4.6 VEGETATION/SOIL

Very low amounts of airborne radionuclides are emitted at the Paducah Site from DOE sources. A portion of the airborne radionuclides is estimated to be deposited in soil and on vegetation. The Paducah Site estimates doses through the food chain to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.7 ANIMAL PRODUCTS

Very low amounts of airborne radionuclides are emitted at the Paducah Site from DOE sources. A portion of the airborne radionuclides are estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering

plants and lawns). The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.8 WATERSHED BIOLOGICAL MONITORING

Historically, a Watershed Monitoring Plan (WMP) was required to meet KPDES permit requirements. The WMP detailed the Paducah Site's biological monitoring program.

In 2011, the WMP was modified to eliminate the requirement for biological monitoring in the creeks surrounding the site. The justification for elimination of biological monitoring in creeks was that, over the years, the watersheds had been sampled extensively to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community; therefore, biological sampling no longer was required. Elimination of the program also was supported by the fact that measured concentrations associated with radionuclides of concern at the Paducah Site in fish were low and there was an overall downward trend in the concentration of contaminants due to remediation efforts.

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5. DOSE CALCULATIONS

Effluent releases due to operations at the Paducah Site from DOE sources may contain radionuclides. After release, these substances disperse through the environment by transport mechanisms by which they eventually may reach and affect humans. This section describes the methodologies used to model the dispersion of radionuclides and to estimate human exposure resulting from the intake of the dispersed radionuclides. Human exposures to radionuclides are characterized in terms of TED to the public MEI and to the entire population residing within 50 miles of the site. Site-specific pathways may be used that have current or potential future pathways that are not listed in the Risk Methods Document (DOE 2019a). The Risk Methods Document states that during the DQO process for a specific project, risk analyses will be used to identify qualitatively the preliminary chemicals of potential concern, receptors that may be exposed to contaminants, locations at which exposure may occur, and pathways by which contaminants may reach these locations. This information will be used to develop the conceptual site model against which the new data collected can be compared. Exposure factors will be based on information contained in the Risk Methods Document or in consultation with project teams for site-specific parameters. In addition to the dose assessments in support of the ASER, individual projects also may perform dose assessments to establish bounding scenarios to ensure that any future public radiological exposures are maintained within the limits established in DOE Orders. The assumptions and parameters used in these project-specific assessments are found within the individual project technical derivations.

5.1 CONFORMANCE WITH STANDARDS FOR PUBLIC DOSE CALCULATIONS

Models selected to assess environmental transport of and human exposures to substances released from DOE operations are codified or approved for use by DOE. The models are appropriate for the physical and environmental situation encountered and for the data available to characterize the situation. Input data, including default values, are documented and evaluated for applicability to the situation being modeled.

A complete set of potential human exposure pathways is considered in the assessments of radiological exposures. Those pathways that represent the potential exposures to the most exposed individual and to the entire population residing within 49.7 miles of the site are evaluated as appropriate. The pathways that are evaluated are discussed in Sections 5.3 and 5.4.

Descriptions of the models and computer codes may consist of references to published descriptions or of actual mathematical formulations developed for special calculations. Surface water and groundwater modeling are conducted, as necessary, to conform to applicable requirements of the Commonwealth of Kentucky and of the regional EPA office.

5.2 MAJOR CONSIDERATIONS

Members of the public may receive radiation doses from the Paducah Site from DOE sources from materials released to the air and waters. In addition, some members of the public may receive minor radiation doses through direct external irradiation by radiation emanating from the cylinder yards located within the secured area of the plant. Doses are estimated for all potentially important exposure pathways relevant to the above exposure media. Table 3 lists environmental release and transport mechanisms that apply to emissions from DOE operations. Estimation of the consequences of radionuclide or chemical

Table 3. Environmental Transport Mechanisms Applicable to Releases from DOE Operations

Releases to water	Remain dissolved or suspended in water Deposit on ground via irrigation* Deposit on vegetation via irrigation* Deposit in sediment Uptake to biota
Releases to air	Remain suspended in air Deposit on ground Deposit on vegetation Uptake to biota

*The protective measures taken in support of the Water Policy preclude the use of potentially contaminated water for irrigation. The inclusion of irrigation as a potentially completed exposure pathway is for informational purposes only, and the doses are not modeled.

releases from DOE operations must consider all potential pathways by which these materials may reach the surrounding population. To aid in selecting potentially important pathways, a land use survey was performed. This survey recorded and mapped the locations of all residences, farms for animal products, and vegetable gardens within a 3-mile radius of the site. All identified locations were plotted on a map divided into 16 equal sectors corresponding to the 16 cardinal compass points. This land use survey and other potential pathways are summarized in the Risk Methods Document (DOE 2019a).

This information was compared to modeling results to identify the MEI. Demographic data were obtained from the Bureau of the Census to document characteristics of the people who live near the site. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure that there have been no changes to property ownership.

As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the Paducah Site.

No resident or business responding to the survey reported using a private intake on the Ohio River or on Bayou Creek or Little Bayou Creek for any part of their water supply. On the Ohio River, the nearest downstream water-intake point used for drinking water is at Cairo, Illinois. Cairo is within 50 miles of the Paducah Site, and drinking water concentrations to the population at that location are considered in the dose assessment.

Figures 2 and 3 list potential environmental pathways to humans and associated media for the transport mechanisms given in Table 3. Sections 5.3, 5.4, and 5.5 discuss the environmental transport, food chain, and dosimetric models used to evaluate human exposures due to current or past DOE operations. Input data to the models are evaluated using site-specific (collected under the EM and surveillance activities described earlier in this plan), historical data, and generic (default) values.

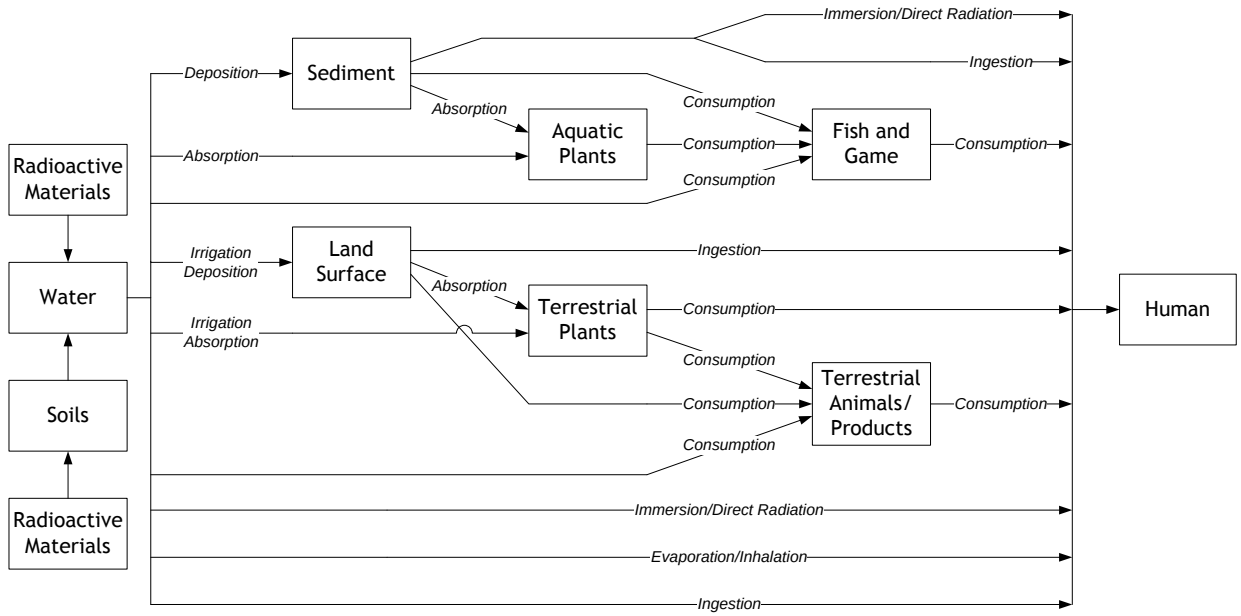

Figure 2. Possible Pathways between Radioactive Material Released to the Water and Humans

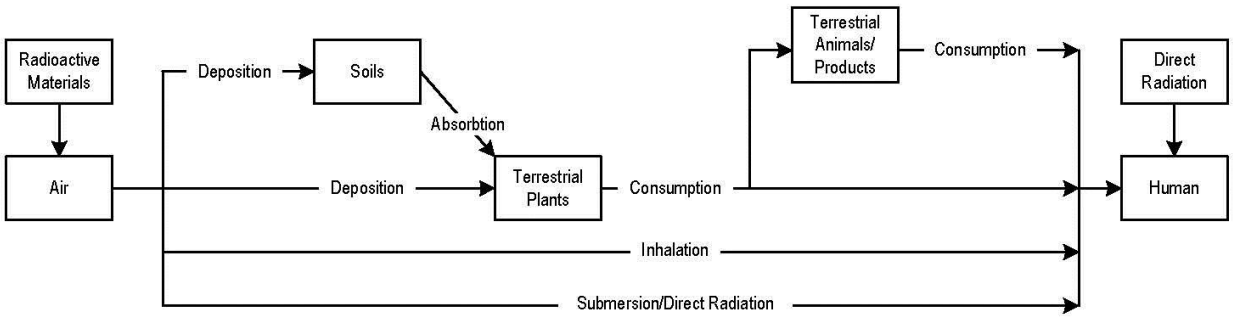

Figure 3. Possible Pathways between Radioactive Materials Released to the Air and Humans

5.3 TRANSPORT MODELS

This section describes the methodologies used to characterize environmental concentrations of radiological materials released from current or past DOE operations. In some cases, transport models are used to predict concentrations; in other cases, measured concentrations are available. When both predicted and measured concentrations are available, the measured concentrations are used to verify modeling predictions.

5.3.1 Atmospheric Transport

Contaminants released to air may be inhaled by individuals, cause direct radiation by submersion, or deposit on vegetation that may be consumed by farm animals or humans.

Dose calculations on atmospheric releases are described in Section 5.4.1.

5.3.2 Water Transport

Contaminants released to water may remain dissolved or suspended in water (groundwater or surface water), deposited in sediment, deposited on ground or vegetation by irrigation,[3] absorbed into plants and animals, or may infiltrate to the groundwater. Quantities of radionuclides released to surface waters are determined by sampling permitted outfalls in each of the local receiving streams. Contamination of private wells with both Tc-99 and TCE due to releases from historical DOE operations led to a response action in 1988. DOE supplied potable water to affected residents and installed an interim water supply for each resident whose water had TCE above the laboratory reporting limit of 1 ppb. For a long-term water supply, a community water line was extended to the residents with contaminated wells. Irrigation of gardens and watering of livestock using contaminated well water has ceased. Presently, groundwater transport is not modeled for public dose calculations; however, a programmatic working group develops information to support transport modeling. This information is used to better understand sources of contamination found in groundwater off-site and to support risk management decisions made for CERCLA projects.

5.4 ENVIRONMENTAL PATHWAY MODELS

This section describes the methodologies that are used to characterize mechanisms for human uptake and exposure to the radiological contaminant concentrations described in Section 5.3. As in Section 5.3, both modeling and sampling are used to obtain contaminant concentrations in media and foods to which humans may be exposed. In addition, environmental gamma radiation exposure is measured through a dosimetry program.

5.4.1 Contaminants in Air

The ambient air surrounding the Paducah Site is monitored to evaluate public exposure to airborne radionuclides. The results of this ambient air monitoring are used by DOE to demonstrate compliance with Commonwealth of Kentucky and federal regulations as well as with DOE Orders. The DOE contribution to airborne radioactivity from DOE operations at the Paducah Site normally is too low to be detected in the presence of natural background radiation in the environment; therefore, as required under 40 *CFR* § 61, Subpart H, potential doses to the public from point sources also are calculated with a dispersion model. This model calculates how measured quantities of released radionuclides mix with the atmosphere, where they travel, and where they could deposit. Once the dispersion is calculated, population data and concentration/dose conversion factors are used to calculate individual and population doses. These doses include exposure from all the pathways represented in Figure 3, although the primary route of exposure is inhalation. The ambient air monitoring data collected from the ambient air monitoring network are used to assess the impact of emissions of all point and fugitive sources.

The radiation dose calculations are performed using the latest version of CAP-88 computer codes. This package contains EPA's most recent version of the AIRDOS-EPA computer code. The code uses a steady-state, Gaussian plume, atmospheric dispersion model to calculate environmental concentrations of released radionuclides. The code also uses NRC Regulatory Guide 1.109 for food chain models to calculate human exposures, both internal and external, to radionuclides deposited in the environment. DOE uses EPA's latest version of the DARTAB computer code that uses the human exposure values to calculate radiation doses to the public from radionuclides released during the year. The dose calculations

[3] The protective measures taken in support of the Water Policy preclude the use of potentially contaminated water for irrigation. The inclusion of irrigation as a potentially completed exposure pathway is for informational purposes only, and the doses are not modeled.

use dose conversion factors from the latest version of the RADRISK data file, which EPA provides with CAP-88.

5.4.2 Contaminants in Water

Potential direct routes of human exposure to contaminants in waters include ingestion (drinking water, incidental ingestion while swimming), immersion (swimming, wading, showering), direct irradiation (boating, skiing, shoreline use), and inhalation (e.g., release of contaminants during household use of water). Indirect pathways involve deposition on soil and crops by deposition in sediment (Section 5.4.3), contaminants in soil (Section 5.4.4), contaminants in or on food crops (Section 5.4.5), and contaminants in terrestrial animals and fish (Section 5.4.6).

DOE O 458.1 requires conducting radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contaminant levels in 40 *CFR* § 141. Per 40 *CFR* § 141, environmental surveillance data may be used in the vicinity of a nuclear facility to verify compliance with 40 *CFR* § 141 radiological limits for drinking water. Surveillance data from Bayou and Little Bayou Creeks also may be used to verify compliance with 40 *CFR* § 141 prior to their entrance into the Ohio River.

If the surveillance data from Bayou and Little Bayou Creeks exceed the limits for drinking water, samples may be taken at the Cairo, Illinois, intake and compared to the Ohio River background upstream of the Paducah Site to demonstrate DOE compliance.

Surface water is not used for drinking or irrigation near the plant. In 1990, a survey of surface water and groundwater users in the vicinity of the Paducah Site was conducted to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River within 15 miles downstream of the plant. No residents or businesses that responded to the survey questionnaire reported using a private surface water intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. Private groundwater wells were the major water supply for residents surrounding the Paducah Site. Most residents reported using water from their residential wells for drinking, irrigation, and domestic uses. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure there have been no changes to property ownership. Dose to the hypothetical maximally exposed individual is calculated based on incidental ingestion of surface water due to swimming in Bayou and Little Bayou Creeks (outfall locations are not included because water within these locations is not indicative of a body of water that a person could enter). The assumptions based on the Risk Methods Document are that a hypothetical recreator may swim 45 days a year, for 2.6 hours a day, with an incidental ingestion of 0.05 liters per hour, and be in different locations throughout the wildlife management area (DOE 2019a). The highest monthly surface water results from the various sampling locations are utilized to calculate the bounding dose to the maximally exposed individual. Collective dose is not calculated for the incidental ingestion of surface water pathway because it is unlikely that a population of individuals would swim repeatedly in either Bayou or Little Bayou Creeks. This pathway is more likely to involve individuals; therefore, it is more suited for MEI dose calculation.

In September 1988, following the discovery of contamination in residential drinking water wells, water was supplied to all residents whose wells contained detectable levels of TCE and gross beta. In 1992, a Water Policy was developed, which specified that residents in the Water Policy box were to receive supplied water either through bottled water or municipal water. That effort was completed May 31, 1994.

Dose calculations are made for the drinking water pathway if measurable concentrations of radionuclides are found in water samples collected from drinking water systems. Cairo, Illinois, about 36 miles

downstream on the Ohio River, has the nearest drinking water intake to the plant. The dose to a resident from drinking water ingestion is evaluated based on environmental surveillance data, which includes a sample taken at Cairo, Illinois. If site environmental surveillance data is insufficient to meet the requirements of 40 *CFR* § 141 and DOE Order 458.1, additional samples may be taken at the water intake of the drinking water system. Members of the public (adult) are assumed to ingest 2.5 liters per day of drinking water per the Risk Methods Document (DOE 2019a). Collective doses for the drinking water pathway are calculated based on the population of Cairo, Illinois.

Measured concentrations are compared with federal and Commonwealth of Kentucky standards and with historical concentrations for each contaminant found.

5.4.3 Contaminants in Sediment

Discharges from DOE operations to surface waters may result in accumulations in sediment of radionuclides. Potential routes of human exposure from sediment are direct irradiation, indirect pathways, and incidental ingestion. An example of an indirect pathway is a fish ingesting contaminated sediment and subsequent human ingestion of the fish.

External irradiation from contaminated sediment in Little Bayou Creek is a pathway of potential importance. Sediment is known to contain uranium isotopes, Np-237 and Pu-239. Radionuclides deposited on the shores of rivers or creeks may accumulate over a period of time, leading to external irradiation of persons standing on contaminated surfaces. The amount of the nuclides built up on the shoreline depends on the concentration in the water, the depth of deposit, and the length of the period of buildup. The dose to persons depends on the time spent near the contaminants. This exposure time is expected to be minimal because warning signs are posted in this area that indicate the possible presence of contamination. An estimated collective dose for the incidental ingestion of sediment within plant creeks and ditches pathway has been calculated by multiplying the dose to the maximally exposed individual from incidental ingestion of sediment by a total estimated number of visitors hiking within the wildlife management area annually (150 persons), which resulted in a representative collective dose of 0.0081 person-rem (DOE 2019a). This pathway is more likely to involve individuals; therefore, it is more suited for MEI dose calculation.

Incidental ingestion of contaminated sediment may result from exposure during fishing, hunting, or other recreational activities.

5.4.4 Contaminants in Soil

A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

Contaminants also may be deposited in soil due to irrigation of crops from groundwater and/or surface water. As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile

radius, as specified in the 1990 land use survey, and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the site.

No resident or business responding to the survey reported using a private intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. Because irrigation of gardens and watering of livestock using contaminated well water has ceased, this form of exposure is not modeled.

5.4.5 Contaminants in or on Food Crops

A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into food crops. These food crops then may be ingested by the public. The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

Contaminants also may be deposited on vegetation due to irrigation of crops from groundwater and/or surface water. As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the site.

No resident or business responding to the survey reported using a private intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure that there have been no changes to property ownership. Because irrigation of gardens and watering of livestock using contaminated well water has ceased this form of exposure is not modeled.

5.4.6 Contaminants in Terrestrial Animals and Fish

Contaminants may accumulate in animals from eating contaminated feed, drinking contaminated water, and breathing contaminated air. Contaminants may accumulate in fish when they eat contaminated foods and equilibrate with surrounding waters. Indirect pathways for human exposure to contaminants in animals and fish are eating meat and fish. Because both measured concentrations and bioconcentration factors associated with radionuclides of concern at the Paducah Site in animals and fish are low, assessments of these pathways are not performed for the EMP; however, radionuclide impact to animals and fish is evaluated per project based on the expected concentration of radionuclides discharged.

Biota in the aquatic community are not sampled. Biota in the watersheds were sampled previously to the extent that further collection of aquatic organisms would have had deleterious effects on the aquatic community.

A portion of the airborne radionuclides are estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by domestic animals. Domestic animal products then may be ingested by the public. The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion

model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

During the 20-year period of deer harvesting at the site, dose assessments from the ingestion of deer meat were performed using measured concentrations of contaminants. In 2011, an evaluation was conducted of the data sets from the years of deer harvesting events (LATA Kentucky 2011). As a result of this review, the deer harvest was eliminated because of a downward trend and a continued lack of detection in the results, as well as an overall downward trend in the concentration of contaminants found at the Paducah Site due to remediation efforts. The elimination of the deer harvest program was documented in the FY 2012 EMP.

5.4.7 Direct Radiation

The only identified source of potential exposure to the public from radiation emanating from radionuclides contained in structures and other objects is gamma radiation from the uranium cylinder storage yards. It is very improbable that members of the public would be exposed to gamma radiation from these uranium cylinders found in the storage yards due to limited exposure time, distance from the access points of the public to the cylinder yards, and shielding. Collective doses for direct radiation are calculated, based on the total estimated number of visitors hiking within WKWMA annually.

5.5 INTERNAL DOSIMETRY MODELS

The results of all dose calculations are reported in terms of TED, the sum of ED received during the year from external exposures, plus the 50-year committed equivalent dose from intake of radionuclides during the year. Appropriate dose conversion factors based on site-specific factors and uses that are used in the calculations are obtained from DOE O 458.1 reference documents such as these: International Commission on Radiological Protection Publication 60 and 40 *CFR* Part 141, *National Primary Drinking Water Regulations.* Although not used in specific dose calculations, the derived concentration standards given in DOE-STD-1196-2011 given in DOE O 458.1 may be used to infer the acceptability or magnitude of doses associated with measured concentrations of radionuclides in environmental media.

5.6 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

Compliance with DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, regarding the absorbed dose rate limit to native organisms (e.g., invertebrates, fish, raccoons, and muskrats) is demonstrated using generally accepted methods of dose calculation. Current practice estimates absorbed doses by multiplying measured radionuclide concentrations in surface waters by internationally recognized, organism-specific dose rate factors for external and internal exposures and summing the external and internal contributions.

5.7 REPORTS AND RECORDS

Doses to the maximally exposed member of the public and to the population are published in the ASER. In addition, if a radiological release that exceeds any limit contained in paragraphs 4.f.(2), 4.f.(5), 4.g.(4), 4.g.(5)(a), 4.g.(7), 4.g.(8)(a)4 or 4.i.(1) of DOE O 458.1 Chg 3, *Radiation Protection of the Public and the*

Environment, dated January 15, 2013, or exceeds the 40 *CFR* § 61.92 requirements, then the Paducah Site notifies DOE Headquarters.

All input data used in dose calculations are considered as records requiring "permanent retention."

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6. REPORTS

6.1 INTRODUCTION

This section provides an overview of the reporting requirements that are followed by DOE utilizing data generated under the EMP. These requirements have been established in regulations, statutes, and orders issued by regulatory agencies and by DOE and are addressed specifically in the individual sections of this plan. In addition to the reporting requirements listed, data generated under the EMP also is used in preparing regulatory documents completed under the FFA, as appropriate. Revisions to the groundwater conceptual model use data generated under this EMP.

It is the policy of DOE to comply with all applicable environmental requirements, and those listed here are subject to supersession and/or amendment as well as being variable in applicability to individual DOE facilities.

6.2 REPORTING REQUIREMENTS

The preparation and disposition of reports relevant to EM are shown in Table 4, Applicable Reporting Requirements. The ASER contains a summary for the effluent monitoring and environmental surveillance data for each CY. Data that are collected less frequently than annually are contained in each year's reports until new data are available. The ASER includes comparisons of values of contaminants at sampling locations to average reference values or to environmental standards, criteria, or permit limits. All permit activities, such as mitigation action plans, new requirements, or emission sources are described.

The ASER also includes the information from the Superfund Amendments Reauthorization Act (SARA) 6.3 Title III, Section 313, *Toxic Chemical Release Inventory Report*, on quantities of nonradiological chemical emissions to the environment from unplanned releases. The ASER also includes the chemicals reported in the Emergency Planning and Right-to-Know Act, Section 312, Hazardous Chemical Inventory.

Table 4. Applicable Reporting Requirements

Reporting	Due Date	Source of Requirement	Requirement
ASER	October 1	DOE O 231.1B and DOE O 458.1 (and ERPP)	All DOE facilities that conduct significant environmental protection programs shall prepare an ASER for DOE. The report must provide a comprehensive review of the environmental surveillance programs, status of environmental compliance, and effluent data for nonradioactive pollutants.
Annual NESHAP Compliance Report	June 30	NESHAP 40 *CFR* § 61 Subpart H	Reporting shall include results from monitoring of radionuclide emissions to the ambient air, as well as, required dose calculations. Ambient air monitoring data are included in the NESHAP reports for assessment of fugitive and diffuse emission sources.
Discharge Monitoring Report	The 28th of each month	Clean Water Act	Discharge Monitoring Reports are required for compliance with KPDES permit KY0004049.

Table 4. Applicable Reporting Requirements (Continued)

Reporting	Due Date	Source of Requirement	Requirement
Annual PCB Document	July 1	40 *CFR* § 761.180	The Annual PCB Document is required for PCBs in use and PCB wastes.
SARA Section 313	June 1	SARA Title III	Covered facilities shall report to EPA and the Commonwealth of Kentucky, all environmental releases of specified toxic chemicals that are manufactured, processed, or otherwise used in excess of specified thresholds.
SARA Section 312	March 1	SARA Title III	Annual Hazardous Chemical Inventory Report.
C-746-U Landfill Compliance Monitoring Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045.
Landfill Quarterly Operating Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045.
C-746-S&T Landfills Compliance Monitoring Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045.
C-404 Landfill Groundwater Monitoring Report	May, November	401 *KAR* 34:060	This report is required in accordance with Paducah Hazardous Waste Management Facility Permit KY8-890-008-982.
Environmental Monitoring Plan	October 1 Annually	DOE O 436.1 DOE O 458.1 (and ERPP)	Requires a plan to ensure the site's sustainability; characterize the exposures and doses to individuals and to the population; and evaluate the potential impacts to the biota in the vicinity of DOE activity.
Groundwater Protection Plan	Three Years; Last Updated July 2018	401 *KAR* 5:037	Requires a plan to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution.
Best Management Practices Plan	Five Years; Last Updated May 2018	KPDES permit (KPDES permit is required by the Clean Water Act)	This plan is required by KPDES permit KY0004049.
Spill Prevention Control and Countermeasure (SPCC) Plan	Reviewed Every Three Years; Last Updated April 2018	40 *CFR* § 112	Requires regulated facilities to prepare and implement a SPCC. The purpose of a SPCC Plan is to form a comprehensive spill prevention program that minimizes the potential for discharges.
Annual External Monitoring Report	March 1	DOE O 458.1 (and ERPP)	This report estimates the external dose on an annual basis; summary info also is included in the ASER.
FFA Semiannual Report	April 30 October 30	FFA	This report is required by the FFA. Data generated in many of the sampling programs referenced in Appendix C are reported in this report.

7. REFERENCES

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APPENDIX A

PADUCAH PERMIT SUMMARY

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U.S. DEPARTMENT OF ENERGY PERMIT SUMMARY FOR THE PADUCAH GASEOUS DIFFUSION PLANT

Permit Type	Issuer	Expiration Date	Permit Number	Permittee
AIR				
Title V Air Permit[a]	Kentucky Division for Air Quality	2/25/2020	V-14-012	Four Rivers Nuclear Partnership, LLC (FRNP)
Conditional Major Operating Air Permit	Kentucky Division for Air Quality	3/17/2021	F-15-042	Mid-America Conversion Services, LLC (MCS)
WATER				
Kentucky Pollutant Discharge Elimination System (KPDES)	Kentucky Division of Water (KDOW)	8/30/2022[b]	KY0004049	U.S. Department of Energy (DOE), FRNP, and MCS
Permit to Withdraw Public Water	KDOW	N/A	0900	FRNP
Water Treatment Registration (Public Water System)	KDOW	N/A	PWS No. 0732457	FRNP
SOLID WASTE				
Solid Waste Landfill Permit [C-746-S Residential Landfill (Closed), C-746-T Inert Landfill (Closed), C-746-U Contained Landfill]	Kentucky Division of Waste Management (KDWM)	11/04/2026	SW07300014 SW07300015 SW07300045	DOE/FRNP
RCRA				
Hazardous Waste Management Facility Permit	KDWM	8/25/2025	KY8-890-008-982	DOE/FRNP
Hazardous and Solid Waste Amendments (HSWA) Portion of the RCRA Permit[c]	EPA	04/23/2016	KY8-890-008-982	DOE/FRNP

[a] Operational sampling included in the Title V air permit is considered outside the scope of the Environmental Monitoring Plan. FRNP will implement the appropriate operational sampling to meet the requirements of the Title V air permit.
[b] KPDES permit KY0004049 was renewed in July 2017 with an effective data of September 1, 2017, and combines the previous KY0004049 permit with the KY0102083 permit.
[c] The renewal application has been submitted, but has not been finalized yet.

U.S. DEPARTMENT OF ENERGY COMPLIANCE AGREEMENTS SUMMARY FOR THE PADUCAH GASEOUS DIFFUSION PLANT

Agreement	Effective Date	Expiration Date	Entities
TSCA CA (Toxic Substances Control Act Compliance Agreement)	05/2017 (Modification)	N/A	EPA and DOE
Federal Facility Compliance Agreement Agreed Order/Site Treatment Plan	09/1997	N/A	KDWM and DOE
Federal Facility Agreement	02/1998	Ongoing	Commonwealth of Kentucky, EPA, and DOE
Agreed Order for Waste, Air, and Water Violations	10/2003	Ongoing	Commonwealth of Kentucky and DOE
Agreed Order for DUF_6 Management	10/2003	Ongoing	KDWM and DOE

APPENDIX B

WELL PROGRAM INVENTORY

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ACRONYMS

400GQ	C-400 groundwater well quarterly
400GSA	C-400 groundwater well semiannually
404G	C-404 Landfill groundwater well
A	annually
AB	abandoned
AB-IP	abandoned in place
CARB	residential well sampled under the Carbon Filter Treatment System
CB	colloidal borescope
CM	construction monitoring well
DOE	U.S. Department of Energy
FY	fiscal year
FYR	inspection coordinated with the submittal of the Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Review
GC	geochemical surveillance triennial sampling
GWESA	environmental surveillance annual sampling
GWESBA	environmental surveillance biennial sampling
GWESQ	environmental surveillance quarterly sampling
GWESSA	environmental surveillance semiannual sampling
GWNEQ	groundwater Northeast Plume quarterly sampling
GWNWSA	groundwater Northwest Plume operation and maintenance semiannual sampling
GWNWQ	groundwater Northwest Plume operation and maintenance quarterly sampling
GWSWMU1	groundwater Solid Waste Management Unit 1
KDFWR	Kentucky Department of Fish and Wildlife Resources
KG	C-746-K Landfill groundwater well
LRGA	Lower Regional Gravel Aquifer
M	In the Water Level column, "M" indicates water levels are collected monthly
MW	monitoring well
NA	not applicable
NS	not sampled
PT	pressure transducer
PZ	piezometer
Q	In the Water Level column, "Q" indicates water levels are collected quarterly
R	residential
RGA	Regional Gravel Aquifer
SG	C-746-S&T Landfills groundwater well
SM	semimonthly
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UG	C-746-U Landfill groundwater well
Unknown	information is unknown, cannot be confirmed, or is unavailable
URGA	Upper Regional Gravel Aquifer
WPB-NE	Water Policy Boundary Monitoring Program—Northeast annual sampling
WPB-NW	Water Policy Boundary Monitoring Program—Northwest quarterly sampling

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Table B.1 includes 397 current monitoring wells (MWs) and piezometers (PZs) and a listing of the sampled residential wells.

Table B.1. Well Program Inventory

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW1	RGA	AB 94	NA	NA	NA	NA
MW2	Unknown	AB 88	NA	NA	NA	NA
MW3	Unknown	AB 88	NA	NA	NA	NA
MW4	Unknown	AB 88	NA	NA	NA	NA
MW5	Unknown	AB 88	NA	NA	NA	NA
PZ5G	Unknown	Current	DOE	NS	Q	A
PZ5S	Unknown	Current	DOE	NS	Q	A
MW6	Unknown	AB 88	NA	NA	NA	NA
MW7	UCRS	AB 94	NA	NA	NA	NA
MW8	RGA	AB 94	NA	NA	NA	NA
MW9	RGA	AB 94	NA	NA	NA	NA
MW10	RGA	AB	NA	NA	NA	NA
MW11	UCRS	AB 94	NA	NA	NA	NA
MW12	RGA	AB 94	NA	NA	NA	NA
MW13	UCRS	AB 94	NA	NA	NA	NA
MW14	UCRS	AB 94	NA	NA	NA	NA
MW15	RGA	AB 94	NA	NA	NA	NA
MW16	UCRS	AB 94	NA	NA	NA	NA
MW17	RGA	AB 94	NA	NA	NA	NA
MW18	UCRS	AB 94	NA	NA	NA	NA
MW19	RGA	AB 94	NA	NA	NA	NA
MW20 (also R4)	RGA	Current	KDFWR	NS	Q, SM	A
MW21	RGA	AB 94	NA	NA	NA	NA
MW22	RGA	AB 94	NA	NA	NA	NA
MW23	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW24	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW25	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW26	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW27	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW28	UCRS	AB 94	NA	NA	NA	NA
MW29	UCRS	AB 94	NA	NA	NA	NA
MW30	UCRS	AB 94	NA	NA	NA	NA
MW31	UCRS	AB 94	NA	NA	NA	NA
MW32	UCRS	AB 94	NA	NA	NA	NA
MW33	UCRS	AB	NA	NA	NA	NA
MW34	UCRS	AB 94	NA	NA	NA	NA
MW35	UCRS	AB 94	NA	NA	NA	NA
MW36	UCRS	AB 94	NA	NA	NA	NA
MW37	UCRS	AB 94	NA	NA	NA	NA
MW38	RGA	AB 94	NA	NA	NA	NA
MW39	RGA	AB 94	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW40	RGA	AB 94	NA	NA	NA	NA
MW41	RGA	AB 94	NA	NA	NA	NA
MW42	RGA	AB 94	NA	NA	NA	NA
MW43	RGA	AB 94	NA	NA	NA	NA
MW44	RGA	AB 94	NA	NA	NA	NA
MW45	RGA	AB 87	NA	NA	NA	NA
MW46	RGA	AB 94	NA	NA	NA	NA
MW47	UCRS	AB 94	NA	NA	NA	NA
MW48	RGA	AB 94	NA	NA	NA	NA
MW49	UCRS	AB 94	NA	NA	NA	NA
MW50	RGA	AB 94	NA	NA	NA	NA
MW51	RGA	AB 94	NA	NA	NA	NA
MW52	RGA	AB 94	NA	NA	NA	NA
MW53	RGA	AB 94	NA	NA	NA	NA
MW54	RGA	AB 94	NA	NA	NA	NA
MW55	RGA	AB 87	NA	NA	NA	NA
MW56	UCRS	AB 87	NA	NA	NA	NA
MW57	UCRS	AB 94	NA	NA	NA	NA
MW58	UCRS	AB 90	NA	NA	NA	NA
MW59	RGA	AB	NA	NA	NA	NA
MW60	UCRS	AB	NA	NA	NA	NA
MW61	RGA	AB	NA	NA	NA	NA
MW62	RGA	AB	NA	NA	NA	NA
MW63	RGA	Current	DOE	GWNWSA	Q	A
MW64	UCRS	Current	DOE	NS	Q	A
MW65	RGA	Current	DOE	GWNWSA	Q	A
MW66	RGA	Current	DOE	GWNWSA	Q	A
MW67	RGA	Current	DOE	GWESBA, 404G	Q	A
MW68	RGA	Current	DOE	GWESA	Q	A
MW69	UCRS	Current	DOE	NS	Q	A
MW70	RGA	AB 94	NA	NA	NA	NA
MW71	RGA	Current	DOE	GWESA	Q, M	A
MW72	RGA	Current	DOE	NS	Q	A
MW73	RGA	Current	DOE	NS	Q	A
PZ74	UCRS	Current	DOE	NS	Q	A
MW75	UCRS	Current	DOE	NS	Q	A
MW76	RGA	Current	DOE	GWESBA, 404G	Q	A
MW77 (PZ)	RGA	Current	DOE	NS	Q	A
MW78	RGA	Current	DOE	NS	Q	A
MW79	RGA	Current	DOE	NS	Q	A
MW80	RGA	Current	DOE	NS	Q	A
MW81	RGA	Current	DOE	NS	Q	A
MW82	UCRS	Current	DOE	NS	Q	A
MW83	UCRS	Current	DOE	NS	Q	A
MW84	RGA	AB 2019	NA	NA	NA	NA
MW84A	RGA	Current	DOE	404G	Q	A
MW85	UCRS	Current	DOE	404G	Q	A
MW86	RGA	Current	DOE	GWESBA, 404G	Q	A
MW87	RGA	AB 2019	NA	NA	NA	NA
MW87A	RGA	Current	DOE	404G	Q	A
MW88	UCRS	Current	DOE	404G	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW89	RGA	Current	DOE	GWESBA, 404G	Q	A
MW90	RGA	AB 2001	NA	NA	NA	NA
MW90A	RGA	Current	DOE	404G	Q	A
MW91	UCRS	AB 2017	NA	NA	NA	NA
MW91A	UCRS	Current	DOE	404G	Q	A
MW92	RGA	Current	DOE	GWESBA, 404G	Q	A
MW93	RGA	AB 2019	NA	NA	NA	NA
MW93A	RGA	Current	DOE	404G	Q	A
MW94	UCRS	Current	DOE	404G	Q	A
MW95	RGA	AB 2001	NA	NA	NA	NA
MW95A	RGA	Current	DOE	GWESBA, 404G	Q	A
MW96	UCRS	Current	DOE	NS	Q	A
MW97	RGA	AB 97	NA	NA	NA	NA
MW98	RGA	Current	DOE	GWESSA	Q	A
MW99	RGA	Current	TVA	GWESA, GC	M, Q	A
MW100	RGA	Current	TVA	GWESA, GC	M, Q	A
PZ101	Terrace Gravel	Current	DOE	NS	Q	A
MW102	McNairy	Current	DOE	GWESSA	Q	A
MW103	RGA	Current	DOE	GWESBA	Q	A
MW104	UCRS	AB 96	NA	NA	NA	NA
MW105	RGA	AB	NA	NA	NA	NA
MW106	RGA	AB 2014	NA	NA	NA	NA
MW106A	RGA	Current	DOE	GWESBA, WPB-NW	Q, SM	A
PZ107	RGA	Current	DOE	NS	Q	A
MW108	RGA	Current	DOE	NS	Q	A
PZ109	RGA	Current	DOE	NS	Q	A
PZ110	RGA	Current	DOE	NS	Q	A
PZ111	UCRS	Current	DOE	NS	Q	A
PZ112	UCRS	AB 2017	NA	NA	NA	NA
PZ113	RGA	AB 2017	NA	NA	NA	NA
PZ114	McNairy	Current	DOE	NS	Q	A
PZ115	McNairy	Current	DOE	NS	Q	A
PZ116	RGA	AB 2017	NA	NA	NA	NA
PZ117	RGA	Current	DOE	NS	Q	A
PZ118	RGA	Current	DOE	NS	Q	A
MW119	RGA	AB	NA	NA	NA	NA
MW120	McNairy	Current	DOE	GWESSA	Q	A
MW121	McNairy	Current	KDFWR	GWESSA	Q, SM	A
MW122	McNairy	Current	DOE	GWESSA	Q	A
MW123	RGA	Current	KDFWR	NS	Q	A
MW124	RGA	Current	DOE	GWNEQ	Q	A
MW125	RGA	Current	KDFWR	GWESA, GC	Q	A
MW126	RGA	Current	DOE	GWNEQ	M, Q	A
MW127	UCRS	AB-IP	NA	NA	NA	NA
MW128	UCRS	AB-IP	NA	NA	NA	NA
MW129	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW130	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW131	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW132	RGA	Current	DOE	NS	M, Q	A
MW133	McNairy	Current	TVA	GWESSA	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW134	RGA	Current	KDFWR	GC, WPB-NW	Q, SM	A
MW135	RGA	Current	TVA	GWESSA	M, Q	A
MW136	UCRS	AB	NA	NA	NA	NA
MW137	RGA	Current	TVA	NS	M, Q	A
MW138	UCRS	Current	TVA	NS	Q	A
MW139	RGA	Current	DOE	GWESA	M, Q	A
MW140	McNairy	AB	NA	NA	NA	NA
MW141	RGA	AB 98	NA	NA	NA	NA
MW142	RGA	AB 98	NA	NA	NA	NA
MW143	UCRS	AB 98	NA	NA	NA	NA
MW144	RGA	Current	DOE	GWNEQ	Q	A
MW145	RGA	Current	DOE	GWNEQ, GC	M, Q	A
MW146	RGA	Current	TVA	GWESBA, WPB-NW	Q	A
MW147	RGA	Current	TVA	NS	M, Q	A
MW148	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW149	UCRS	Current	Private—Residential	GWESBA	Q	A
MW150	RGA	Current	Private—Residential	GWESA	M, Q	A
MW151	Terrace Gravels	Current	Private—Residential	NS	Q	A
MW152 [f]	RGA	AB 2018	NA	NA	NA	NA
MW153 [g]	UCRS	AB 2018	NA	NA	NA	NA
MW154	UCRS	Current	DOE	NS	Q	A
MW155	RGA	Current	DOE	400GQ, GWNEQ	Q	A
MW156	RGA	Current	DOE	400GQ, GWNEQ	Q	A
MW157	UCRS	Current	DOE	NS	Q	A
MW158	RGA	AB 99	NA	NA	NA	NA
MW159	RGA	AB 99	NA	NA	NA	NA
MW160	UCRS	AB 99	NA	NA	NA	NA
MW161	RGA	Current	DOE	GWSWMU1, GWESA, GC	Q	A
MW162	UCRS	Current	DOE	NS	Q	A
MW163	RGA	Current	DOE	GWESBA, GWNEQ, GC	Q	A
MW164	UCRS	Current	DOE	NS	Q	A
MW165	RGA	AB 2014	NA	NA	NA	NA
MW165A	RGA	Current	DOE	GWNWSA	Q	A
MW166	UCRS	Current	DOE	NS	Q	A
MW167	UCRS	Current	DOE	NS	Q	A
MW168	RGA	Current	DOE	GWESBA	Q	A
MW169	RGA	Current	DOE	GWESBA	Q	A
MW170	UCRS	Current	DOE	NS	Q	A
MW171	UCRS	Current	DOE	NS	Q	A
MW172	UCRS	Current	DOE	NS	Q	A
MW173	RGA	Current	DOE	GWNWSA	Q	A
MW174	UCRS	Current	DOE	GWESBA	Q	A
MW175	RGA	Current	DOE	400GSA	Q	A
MW176	UCRS	Current	DOE	NS	Q	A
MW177	UCRS	Current	DOE	NS	Q	A
MW178	RGA	Current	DOE	400GQ	Q	A
MW179	RGA	AB 2003	NA	NA	NA	NA
MW180	UCRS	Current	DOE	NS	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW181	RGA	AB 2000	NA	NA	NA	NA
MW182	UCRS	Current	DOE	GWESA	Q	A
183, Not Installed	NA	NA	NA	NA	NA	NA
MW184	UCRS	AB 98	NA	NA	NA	NA
MW185	RGA	Current	DOE	NS	Q	A
MW186	UCRS	Current	DOE	GWESBA	Q	A
MW187	UCRS	Current	DOE	GWESBA	Q	A
MW188	RGA	Current	DOE	GC	Q	A
MW189	UCRS	Current	DOE	NS	Q	A
MW190	UCRS	Current	DOE	NS	Q	A
MW191	RGA	Current	DOE	GWESA	M, Q	A
MW192	UCRS	Current	DOE	NS	Q	A
MW193	RGA	Current	DOE	GWESBA, GC	M, Q	A
MW194	RGA	Current	KDFWR	WPB-NW	Q, SM	A
MW195	UCRS	AB 94	NA	NA	NA	NA
MW196	Terrace Gravels	Current	DOE	NS	Q	A
MW197	RGA	Current	DOE	GWESSA	Q	A
MW198	UCRS	Current	DOE	NS	Q	A
MW199	RGA	Current	Private—Residential	WPB-NW	Q, SM	A
MW200	RGA	Current	KDFWR	GWESBA	Q	A
MW201	RGA	Current	KDFWR	GWESBA, GC, WPB-NW	Q, SM	A
MW202	RGA	Current	KDFWR	GWESBA, WPB-NW	Q, SM	A
MW203	RGA	Current	DOE	GWESA	Q	A
MW204	UCRS	Current	DOE	NS	Q	A
MW205	RGA	Current	DOE	GWESBA	Q	A
MW206	RGA	AB 2014	NA	NA	NA	NA
MW207	UCRS	Current	DOE	NS	Q	A
MW208	UCRS	AB 2012	NA	NA	NA	NA
MW209	UCRS	AB 2016	DOE	NS	NA	NA
MW210	UCRS	Current	DOE	NS	Q	A
MW211	UCRS	Current	DOE	NS	Q	A
MW212	UCRS	Current	DOE	NS	Q	A
MW213	UCRS	Current	DOE	NS	Q	A
MW214	UCRS	Current	DOE	NS	Q	A
MW215	UCRS	Current	DOE	NS	Q	A
MW216	UCRS	Current	DOE	NS	Q	A
MW217	UCRS	Current	DOE	NS	Q	A
MW218	UCRS	Current	DOE	NS	Q	A
MW219	UCRS	Current	DOE	NS	Q	A
MW220	RGA	Current	DOE	SG	Q	A
MW221	RGA	Current	DOE	SG	Q	A
MW222	RGA	Current	DOE	SG	Q	A
MW223	RGA	Current	DOE	SG	Q	A
MW224	RGA	Current	DOE	SG	Q	A
MW225	URGA	Current	DOE	NS	Q	A
MW226	RGA	Current	DOE	GWESBA, 404G	Q	A
MW227	RGA	Current	DOE	GWESBA, 404G	Q	A
228, Not Installed	NA	NA	NA	NA	NA	NA
229, Not Installed	NA	NA	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
230, Not Installed	NA	NA	NA	NA	NA	NA
231, Not Installed	NA	NA	NA	NA	NA	NA
232, Not Installed	NA	NA	NA	NA	NA	NA
MW233	RGA	Current	KDFWR	NS	Q	A
MW234	RGA	AB 2002	NA	NA	NA	NA
MW235	RGA	AB 2002	NA	NA	NA	NA
MW236	RGA	Current	KDFWR	GWESA	Q	A
MW237	UCRS	Current	KDFWR	NS	Q	A
MW238	RGA	Current	KDFWR	NS	Q	A
MW239	McNairy	Current	KDFWR	GWESSA	Q	A
MW240	RGA	Current	KDFWR	GWESA	Q	A
MW241	RGA	AB 2003	NA	NA	NA	NA
MW241A	RGA	Current	KDFWR	NS	Q	A
MW242	RGA	Current	DOE	GWNWSA, GC	Q	A
MW243	RGA	Current	DOE	GWNWSA	Q	A
MW244	RGA	Current	DOE	GWNWSA	Q	A
MW245	RGA	Current	DOE	GWNWSA	Q	A
MW246	UCRS	Current	DOE	NS	Q	A
MW247	McNairy	Current	DOE	GWESSA	Q	A
MW248	RGA	Current	DOE	GWNWSA	Q	A
MW249	RGA	Current	DOE	NS	Q	A
MW250	RGA	Current	DOE	GWNWSA	Q	A
PZ251	UCRS	Current	DOE	NS	Q	A
MW252	RGA	Current	Private—Residential	GWESA	M, Q	A
MW253	RGA	AB 2019	NA	NA	NA	NA
MW253A	RGA	Current	Private—Residential	GWESA	M, Q	A
254, Not Installed	NA	NA	NA	NA	NA	NA
MW255	RGA	Current	DOE	GWNEQ	Q	A
MW256	RGA	Current	DOE	GWNEQ, GC	Q	A
MW257	RGA	Current	DOE	GC	Q	A
MW258	RGA	Current	DOE	GWNEQ, GC	Q	A
259, Not Installed	NA	NA	NA	NA	NA	NA
MW260	RGA	Current	DOE	GWESBA, GWNEQ, GC	Q	A
MW261	RGA	Current	DOE	GWESA, GC	Q	A
MW262	RGA	Current	DOE	GWESBA	M, Q	A
MW263	RGA	AB 2003	NA	NA	NA	NA
MW264	RGA	AB 2003	NA	NA	NA	NA
MW265	RGA	AB 2000	NA	NA	NA	NA
MW266	RGA	AB 2003	NA	NA	NA	NA
MW267	RGA	AB 2003	NA	NA	NA	NA
MW268	RGA	AB 2002	NA	NA	NA	NA
MW269	RGA	AB 2002	NA	NA	NA	NA
MW270	RGA	AB 2000	NA	NA	NA	NA
MW271	RGA	AB 2002	NA	NA	NA	NA
MW272	RGA	AB 2002	NA	NA	NA	NA
MW273	RGA	AB 2002	NA	NA	NA	NA
MW274	RGA	AB 2002	NA	NA	NA	NA
MW275	RGA	AB 2002	NA	NA	NA	NA
MW276	RGA	AB 2002	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW277	RGA	AB 2000	NA	NA	NA	NA
PZ278	UCRS	AB 97	NA	NA	NA	NA
PZ279	UCRS	AB 97	NA	NA	NA	NA
PZ280	UCRS	AB 97	NA	NA	NA	NA
PZ281	UCRS	AB 97	NA	NA	NA	NA
PZ282	UCRS	AB 97	NA	NA	NA	NA
MW283	RGA	Current	DOE	GWNEQ	Q	A
MW284	RGA	Current	DOE	NS	Q	A
285, Not Installed	NA	NA	NA	NA	NA	NA
286, Not Installed	NA	NA	NA	NA	NA	NA
PZ287	RGA	Current	DOE	NS	Q	A
MW288	RGA	Current	DOE	GWNEQ, GC	Q	A
PZ289	RGA	Current	DOE	NS	Q	A
PZ290	RGA	Current	DOE	NS	Q	A
MW291	RGA	Current	DOE	GWNEQ	M, Q	A
MW292	RGA	Current	DOE	GWNEQ, GC	Q	A
MW293	RGA	AB 2003	NA	NA	NA	NA
MW293A	RGA	Current	DOE	GWNEQ	Q	A
MW294	RGA	AB 2003	NA	NA	NA	NA
MW294A	RGA	Current	DOE	NS	Q	A
295, Not Installed	NA	NA	NA	NA	NA	NA
296, Not Installed	NA	NA	NA	NA	NA	NA
297, Not Installed	NA	NA	NA	NA	NA	NA
298, Not Installed	NA	NA	NA	NA	NA	NA
299, Not Installed	NA	NA	NA	NA	NA	NA
MW300	Terrace Gravels	Current	DOE	KG	Q	A
MW301	Terrace Gravels	AB 2014	NA	NA	NA	NA
MW302	Terrace Gravels	Current	DOE	KG	Q	A
MW303	Terrace Gravels	AB 94	NA	NA	NA	NA
MW304	Terrace Gravels	Current	DOE	NS	Q	A
MW305	Eocene	Current	DOE	NS	Q	A
MW306	Eocene	Current	DOE	NS	Q	A
MW307	Eocene	Current	DOE	NS	Q	A
MW308	Eocene	Current	DOE	NS	Q	A
MW309	Terrace Gravels	Current	DOE	NS	Q	A
MW310	Terrace Gravels	Current	DOE	NS	Q	A
MW311	Terrace Gravels	Current	DOE	NS	Q	A
MW312	UCRS	AB 2016	DOE	NS	NA	NA
MW313	UCRS	Current	DOE	NS	Q	A
MW314	UCRS	AB 2016	DOE	NS	NA	NA
MW315	UCRS	Current	DOE	NS	Q	A
MW316	UCRS	Current	DOE	NS	Q	A
MW317	Terrace Gravels	Current	DOE	NS	Q	A
MW318	Terrace Gravels	AB 2016	DOE	NS	NA	NA
319, Not Installed	NA	NA	NA	NA	NA	NA
320, Not Installed	NA	NA	NA	NA	NA	NA
321, Not Installed	NA	NA	NA	NA	NA	NA
322, Not Installed	NA	NA	NA	NA	NA	NA
323, Not Installed	NA	NA	NA	NA	NA	NA
324, Not Installed	NA	NA	NA	NA	NA	NA
MW325	RGA	Current	DOE	NS	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW326	RGA	Current	DOE	NS	Q	A
MW327	RGA	Current	DOE	NS	Q	A
MW328	RGA	Current	DOE	GWESBA, GC	Q	A
MW329	RGA	Current	DOE	GWESBA, GC	Q, SM	A
MW330	RGA	Current	DOE	NS	Q	A
331, Not Installed	NA	NA	NA	NA	NA	NA
332, Not Installed	NA	NA	NA	NA	NA	NA
MW333	RGA	Current	DOE	GWESBA, 404G	Q	A
PZ334	UCRS	Current	DOE	NS	Q	A
PZ335	UCRS	Current	DOE	NS	Q	A
PZ336	UCRS	Current	DOE	NS	Q	A
MW337	RGA	Current	DOE	GWESBA, 404G	Q	A
MW338	RGA	Current	DOE	GWESBA, 404G	Q	A
MW339	RGA	Current	DOE	GWNWSA, GC	Q	A
MW340	RGA	Current	DOE	GWNWSA	Q	A
MW341	RGA	Current	DOE	400GQ, GWNEQ, GWESBA	Q	A
MW342	RGA	Current	DOE	400GSA	Q	A
MW343	LRGA	Current	DOE	GWESBA, 400GSA, GC	Q	A
MW344	Terrace Gravels	Current	DOE	KG	Q	A
MW345	Rubble Zone	Current	DOE	GWESA	Q	A
MW346	Rubble Zone	Current	DOE	NS	Q	A
MW347	Rubble Zone	Current	DOE	NS	Q	A
PZ348	UCRS	Current	DOE	NS	Q	A
PZ349	RGA	Current	DOE	NS	Q	A
PZ350	UCRS	Current	DOE	NS	Q	A
PZ351	RGA	Current	DOE	NS	Q	A
MW352	RGA	AB 2002	NA	NA	NA	NA
MW353	RGA	Current	DOE	NS	M, Q	A
MW354	RGA	Current	DOE	GWESQ	Q, SM	A
MW355	RGA	Current	DOE	GWNWSA	Q	A
MW356 [a]	McNairy	Current	DOE	GWESSA	Q	A
MW357	URGA	Current	DOE	UG	Q	A
MW358	LRGA	Current	DOE	UG	Q	A
MW359	UCRS	Current	DOE	UG	Q	A
MW360	URGA	Current	DOE	UG	Q	A
MW361	LRGA	Current	DOE	UG	Q	A
MW362	UCRS	Current	DOE	UG	Q	A
MW363	URGA	Current	DOE	UG	Q	A
MW364	LRGA	Current	DOE	UG	Q	A
MW365	UCRS	Current	DOE	UG	Q	A
MW366	URGA	Current	DOE	UG	M, Q	A
MW367	LRGA	Current	DOE	UG	Q	A
MW368	UCRS	Current	DOE	UG	Q	A
MW369	URGA	Current	DOE	UG/SG	Q	A
MW370	LRGA	Current	DOE	UG/SG	Q	A
MW371	UCRS	Current	DOE	UG	Q	A
MW372	URGA	Current	DOE	UG/SG	Q	A
MW373	LRGA	Current	DOE	UG/SG	Q	A
MW374	UCRS	Current	DOE	UG	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW375	UCRS	Current	DOE	UG	Q	A
MW376	LRGA	Current	DOE	UG	Q	A
MW377	UCRS	Current	DOE	UG	Q	A
378, Not Installed	NA	NA	NA	NA	NA	NA
379, Not Installed	NA	NA	NA	NA	NA	NA
MW380	RGA	Current	KDFWR	NS	Q	A
MW381	RGA	Current	KDFWR	GC	Q	A
382, Not Installed	NA	NA	NA	NA	NA	NA
383, Not Installed	NA	NA	NA	NA	NA	NA
MW384	URGA	Current	DOE	SG	Q	A
MW385	LRGA	Current	DOE	SG	Q	A
MW386	UCRS	Current	DOE	SG	Q	A
MW387	URGA	Current	DOE	SG	Q	A
MW388	LRGA	Current	DOE	SG	Q	A
MW389	UCRS	Current	DOE	SG	Q	A
MW390	UCRS	Current	DOE	SG	Q	A
MW391	URGA	Current	DOE	SG	Q	A
MW392	LRGA	Current	DOE	SG	Q	A
MW393	UCRS	Current	DOE	SG	Q	A
MW394	URGA	Current	DOE	SG	M, Q	A
MW395	LRGA	Current	DOE	SG	Q	A
MW396	UCRS	Current	DOE	SG	Q	A
MW397	LRGA	Current	DOE	SG	Q	A
398, Not Installed	NA	NA	NA	NA	NA	NA
399, Not Installed	NA	NA	NA	NA	NA	NA
400, Not Installed	NA	NA	NA	NA	NA	NA
MW401	RGA	Current	DOE	NS	Q	A
MW402	RGA	Current	DOE	NS	Q	A
MW403	RGA	Current	DOE	GWESQ, GC	Q	A
MW404	RGA	Current	DOE	GWESBA, GC	Q	A
MW405	RGA	Current	DOE	GWESBA, 400GQ	Q	A
MW406	RGA	Current	DOE	GWESBA, 400GQ	Q	A
MW407	RGA	Current	DOE	GWESBA, 400GQ	Q	A
MW408	RGA	Current	DOE	GWESBA, 400GQ	Q	A
MW409	RGA	Current	Private—Residential	GWESSA, GC	M, Q	A
MW410	RGA	Current	Private—Residential	GWESSA	M, Q	A
MW411	RGA	Current	Private—Residential	GWESSA	M, Q	A
412, Not Installed	NA	NA	NA	NA	NA	NA
413, Not Installed	NA	NA	NA	NA	NA	NA
MW414	RGA	Current	DOE	404G, GWESBA, GC	Q	A
MW415	RGA	Current	DOE	GWESBA	Q	A
MW416	RGA	Current	DOE	404G, GWESBA	Q	A
MW417	RGA	Current	DOE	GWESBA	Q	A
MW418	RGA	Current	DOE	GWESA	M, Q	A
MW419	RGA	Current	DOE	GWESA	Q	A
MW420	URGA	Current	DOE	404G	Q	A
MW421	RGA	Current	DOE	400GSA	Q	A
MW422	RGA	Current	DOE	400GSA	Q	A
MW423	RGA	Current	DOE	400GSA	Q	A
MW424	RGA	Current	DOE	400GSA	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW425	RGA	Current	DOE	400GSA	Q	A
MW426	RGA	Current	DOE	GC, WPB-NW	Q, SM	A
MW427	RGA	Current	DOE	GC, WPB-NW	Q, SM	A
MW428	RGA	Current	DOE	GWNWSA	Q, SM	A
MW429	RGA	AB 2009	NA	NA	NA	NA
MW429A	RGA	Current	DOE	GWNWSA	Q, SM	A
MW430	RGA	Current	DOE	GWNWSA	Q, SM	A
MW431	RGA	Current	DOE	GWESQ	Q, SM	A
MW432	RGA	Current	DOE	GWESBA, WPB-NW	Q, SM	A
MW433	RGA	Current	TVA	WPB-NW	Q	A
434, Not Installed	NA	NA	NA	NA	NA	NA
MW435	RGA	Current	TVA	GWESBA, WPB-NW	Q	A
436, Not Installed	NA	NA	NA	NA	NA	NA
437, Not Installed	NA	NA	NA	NA	NA	NA
438, Not Installed	NA	NA	NA	NA	NA	NA
MW439	RGA	Current	TVA	GWESBA, GC	Q	A
MW440	RGA	Current	TVA	NS	Q	A
MW441	RGA	Current	TVA	GC, WPB-NW	Q	A
MW442	RGA	Current	KDFWR	GWESBA	Q	A
MW443	RGA	Current	KDFWR	GWESBA	Q	A
MW444	RGA	Current	KDFWR	GWESBA	Q	A
MW445	RGA	Current	TVA	GWESBA	M, Q	A
446, Not Installed	NA	NA	NA	NA	NA	NA
MW447	RGA	Current	TVA	GWESBA, GC	Q	A
MW448	RGA	Current	KDFWR	GWESBA	Q	A
449, Not Installed	NA	NA	NA	NA	NA	NA
MW450	RGA	Current	KDFWR	GWESBA	Q	A
MW451	RGA	Current	KDFWR	GWESBA	Q	A
MW452	RGA	Current	KDFWR	GWESBA, WPB-NW	Q	A
MW453	RGA	Current	KDFWR	GWESA	Q	A
MW454	RGA	Current	KDFWR	GWESA	Q	A
MW455	RGA	Current	DOE	GWNWSA	Q	A
MW456	RGA	Current	DOE	GWNWSA	Q	A
MW457	RGA	Current	DOE	GWNWSA	Q	A
MW458	RGA	Current	DOE	GWNWSA	Q	A
MW459	RGA	Current	DOE	GWNWSA	M, Q	A
MW460	RGA	Current	DOE	GWNWQ	Q	A
MW461	RGA	Current	DOE	GWNWSA	Q	A
MW462	RGA	Current	DOE	GWNWSA	Q	A
MW463	RGA	Current	TVA	GWESA	M, Q	A
MW464	RGA	Current	TVA	GWESA	M, Q	A
MW465	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW466	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW467	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW468	RGA	Current	Private—Residential	GWESBA, GC	M, Q	A
MW469	RGA	Current	Private—Residential	GWESA	M, Q	A
MW470	RGA	Current	Private—Residential	GWESA	M, Q	A
MW471	RGA	Current	Private—Residential	GWESA	M, Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW472	RGA	Current	Private—Residential	GWESA	M, Q	A
MW473	RGA	Current	Private—Residential	GWESBA, GC	M, Q	A
MW474	RGA	Current	Private—Residential	GWESBA, GC	M, Q	A
MW475	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW476	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW477	RGA	Current	TVA	GWESBA	M, Q	A
MW478	RGA	Current	DOE	GWESBA, GWNEQ	Q	A
MW479	RGA	Current	DOE	GWESBA, GWNEQ	Q	A
MW480	RGA	Current	DOE	GWESBA, GWNEQ	Q	A
MW481	RGA	Current	DOE	GWESBA	M, Q	A
MW482	RGA	Current	DOE	GWESBA	M, Q	A
MW483	RGA	Current	Private—Residential	GWESA	M, Q	A
MW484	RGA	Current	Private—Residential	GWESA	M, Q	A
MW485	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW486	RGA	AB 2019	NA	NA	NA	NA
MW486A	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW487	RGA	Current	Private—Residential	GWESBA	M, Q	A
MW488	RGA	Current	Private—Residential	GWESA	M, Q	A
MW489	RGA	Current	KDFWR	GWESBA	Q	A
MW490	RGA	Current	KDFWR	GWESBA	Q	A
MW491	RGA	Current	DOE	GWESBA	M, Q	A
MW492	RGA	Current	DOE	GWESBA	Q	A
MW493	RGA	Current	DOE	GWESBA	Q	A
MW494	RGA	Current	DOE	GWESBA	Q	A
MW495	RGA	Current	DOE	GWESBA, GWNEQ	Q	A
MW496	RGA	Current	DOE	GWESBA, GWNEQ	M, Q	A
MW497	URGA	Current	DOE	GWNWSA	Q	A
MW498	LRGA	Current	DOE	GWNWSA	Q	A
MW499	URGA	Current	DOE	GWNWSA	Q	A
MW500	LRGA	Current	DOE	GWNWSA	Q	A
MW501	URGA	Current	DOE	GWNWSA	Q	A
MW502	LRGA	Current	DOE	GWNWSA	Q	A
MW503	URGA	Current	DOE	GWNWSA	Q	A
MW504	LRGA	Current	DOE	GWNWSA	Q	A
MW505	RGA	Current	DOE	400GQ	Q	A
MW506	RGA	Current	DOE	400GQ	Q	A
MW507	RGA	Current	DOE	400GQ	Q	A
MW508	RGA	AB 2014	DOE	NS	NA	NA
MW509	RGA	AB 2014	DOE	NS	NA	NA
MW510	RGA	AB 2014	DOE	NS	NA	NA
MW511[b]	UCRS	Current	DOE	NS	Q	A
MW512[b]	UCRS	Current	DOE	NS	Q	A
MW513[b]	UCRS	Current	DOE	NS	Q	A
MW514[b]	UCRS	Current	DOE	NS	Q	A
MW515[b]	UCRS	Current	DOE	NS	Q	A
MW516[b]	UCRS	Current	DOE	NS	Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW517 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW518 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW519 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW520 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW521 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW522 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW523 (PZ)[c]	UCRS	Current	DOE	NS	Q	A
MW524[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW525[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW526[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW527[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW528[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW529[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW530[d]	RGA	Current	DOE	GWNEQ[e]	Q	A
MW531	RGA	Current	DOE	GWNEQ	Q	A
MW532 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW533	RGA	Current	DOE	GWNEQ	Q	A
MW534 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW535 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW536	RGA	Current	DOE	GWNEQ	Q	A
MW537	RGA	Current	DOE	GWNEQ	Q	A
MW538	RGA	Current	DOE	GWNEQ	Q	A
MW539	RGA	Current	DOE	GWNEQ	Q	A
MW540 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW541 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW542	RGA	Current	DOE	GWSWMU1	Q	A
MW543	RGA	Current	DOE	GWSWMU1	Q	A
MW544	RGA	Current	DOE	GWSWMU1	Q	A
MW545	RGA	Current	DOE	GWSWMU1	Q	A
MW546	RGA	Current	DOE	GWSWMU1	Q	A
MW547	RGA	Current	DOE	GWSWMU1	Q	A
MW548	RGA	Current	DOE	GWESBA, 404G	Q	A
MW549	RGA	Current	DOE	GWESBA, 404G	Q	A
MW550	RGA	Current	DOE	GWESBA, 404G	Q	A
MW551	RGA	Current	DOE	GWESBA, 404G	Q	A
552, Not Installed	NA	NA	NA	NA	NA	NA
MW553 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW554 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW555 (PZ)[e]	RGA	Current	DOE	NS	Q	A
MW556	RGA	Current	DOE	GWNEQ	Q	A
MW557[h]	Planned	Planned	DOE	NA	NA	NA
MW558[h]	Planned	Planned	DOE	NA	NA	NA
MW559[h]	Planned	Planned	DOE	NA	NA	NA
MW560[h]	Planned	Planned	DOE	NA	NA	NA
MW561[h]	Planned	Planned	DOE	NA	NA	NA
MW562[h]	Planned	Planned	DOE	NA	NA	NA
MW563[h]	Planned	Planned	DOE	NA	NA	NA
MW564[h]	Planned	Planned	DOE	NA	NA	NA
MW565[h]	Planned	Planned	DOE	NA	NA	NA
MW566[h]	Planned	Planned	DOE	NA	NA	NA
MW567[h]	Planned	Planned	DOE	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW568[h]	Planned	Planned	DOE	NA	NA	NA
MW569[h]	Planned	Planned	DOE	NA	NA	NA
MW570[h]	Planned	Planned	DOE	NA	NA	NA
MW571[h]	Planned	Planned	DOE	NA	NA	NA
MW572[h]	Planned	Planned	DOE	NA	NA	NA
MW573[h]	Planned	Planned	DOE	NA	NA	NA
MW574[h]	Planned	Planned	DOE	NA	NA	NA
MW575[i]	Planned	Planned	DOE	NA	NA	NA
MW576[i]	Planned	Planned	DOE	NA	NA	NA
MW577[i]	Planned	Planned	DOE	NA	NA	NA
MW578[i]	Planned	Planned	DOE	NA	NA	NA
MW579[i]	Planned	Planned	DOE	NA	NA	NA
MW580[i]	Planned	Planned	DOE	NA	NA	NA
MW581[i]	Planned	Planned	DOE	NA	NA	NA
MW582[i]	Planned	Planned	DOE	NA	NA	NA
MW583[f]	RGA	Planned	TVA	NA	NA	NA
R2	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R9	Unknown	Current	Private—Residential	WPB-NE	Q	FYR
R10[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R13	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R14	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R20	RGA	Current	Private—Residential	WPB-NE	Q	FYR
R21	Unknown	Current	Private—Residential	WPB-NE	Q	FYR
R22[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R24[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R25[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R26	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R28[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R39[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R40[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R53	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R54[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R69[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA
R83	Unknown	Current	Private—Residential	WPB-NE	Q	FYR
R90	Unknown	Current	Private—Residential	WPB-NE	Q	Outside Water Policy
R114	Unknown	Current	Private—Residential	WPB-NE	Q	Outside Water Policy
R245	Unknown	Current	Private—Residential	WPB-NW	Q	FYR
R302	RGA	Current	Private—Residential	WPB-NE	Q	FYR
R424	RGA	Current	Private—Residential	CARB	NS	Outside Water Policy
R512[j]	Unknown	Unknown	Private—Residential	WPB-NW	NA	NA

Table B.1. Well Program Inventory (Continued)

[a] MW Initial lithologic log indicated well was completed in the RGA; however, the lithology has been reinterpreted to show a higher top of McNairy.
[b] MWs associated with Southwest Plume project. These MWs are not required to be sampled in FY 2020.
[c] PZs associated with the SWMU 4 project. These PZs are scheduled to be abandoned as this project concludes.
[d] Transect monitoring wells associated with the Northeast Plume Optimization project.
[e] PZs associated with the Northeast Plume Optimization project.
[f] MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.
[g] MW153 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin.
[h] MWs planned for the C-400 Remedial Investigation/Feasibility Study.
[i] MWs planned for the SWMUs 211-A&B project.
[j] Residential wells along Bethel Church Road and Ogden Landing Road will be evaluated to determine if they can be sampled in support of the Groundwater Strategy project and Water Policy Box evaluation.
Note: Piezometers now will be given an MW designation and noted as (PZ) to be consistent with the remedial action work plans.
Note: Residential wells inside of the water policy box will be inspected during a Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Review period to verify that the well is not functioning as a water source. There are residential wells that are not sampled and are not listed in this table, but will be included in this inspection. Those residential wells outside of the water policy box may be accessed by the landowner.

Table B.2 includes an inventory of nonconventional borings. Nonconventional borings are defined as those borings that were installed as part of a short-term project where the borings never were part of the Environmental Monitoring well inventory or the borings were not part of the well inventory in recent years.

Table B.2. Nonconventional Borings Inventory

Project Installed	ID	Status
6-Phase	(22) Vacuum Piezometers	Abandoned in 2010
C-400, Phase I	(10) Vacuum Piezometers	Abandoned
Cylinder Drop Test Site Investigation	PE01	Abandoned
	PE02	
	PN01	
	PN02	
	PS01	
	PS02	
	PW01	
	PW02	
	PZ01	
	PZ02	
	PZ03	
	PZ04	
	PZ05	
	PZ06	
	PZ07	
	PZ08	
	PZ09	
	PZ10	
	PZ11	
	PZ12	
Groundwater Phase III	SWMU2-10 (20')	Abandoned
	Z-I	
	Z-2	
	Z-3	
	Z-5	
	Z-6	
	Z-7	
	Z-9	
	Z-10	
	Z-II	
	Z-13	
	Z-14	
	Z-15	

Table B.2. Nonconventional Borings Inventory (Continued)

Project Installed	ID	Status
LASAGNA	2A-PZ01	Abandoned
NE Plume Aquifer Test	PZ1G	Abandoned
	PZ2G	
	PZ4G	
	PZ4S	
Outfalls 10, 11, & 12 Investigation	LB-04 PZ	Abandoned
	011-02PZ	
	012-04 PZ	
	204-02	
	204-07	
	204-08	
	204-09	
	204-10	
	204-11	
	204-12	
	204-14	
	204-15	
	204-26	
	204-27	
Seismic	Z-12	Present
	Z-16	
SI Phase II Aquifer Test	PZ3G	Present
	PZ3S	
SW Plume Permeable Treatment Zone	CM01	Present
	CM02	
	CM03	
	CM04	
	CM05	
	CM06	
	CM07	
	CM08	
	CM09	
	CM10	
	CM11	
	CM12	
SWMU 13 Investigation	1-013-001	Abandoned
	4-013-004	No Evidence of PZ Found
	7-013-009	Abandoned

Table B.2. Nonconventional Borings Inventory (Continued)

Project Installed	ID	Status
UK Creek Studies	BB1A	Abandoned
	BB1B	Abandoned
	BB1Y	Abandoned
	BB1Z	Abandoned
	BB2A	Abandoned
	BB2B	Abandoned
	BB3A	Abandoned
	BB3B	Abandoned
	BB3Y	Abandoned
	BB4A	Abandoned
	BB4B	Destroyed by flood
	BB5A	Destroyed by flood
	BB5B	Abandoned
	BB5C	Abandoned
	BB5Y	Abandoned
	BB5Z	Abandoned
	LB1A	Destroyed by flood
	LB1B	Destroyed by flood
	LB1C	Destroyed by flood
	LB1D	Abandoned
	LB1E	Abandoned
	LB1F	Abandoned
	LB1G	Abandoned
	LB1Y	Abandoned
	LB1Z	Abandoned
	LB2A	Destroyed by flood
	LB2B	Destroyed by flood
	LB2C	Destroyed by flood
	LB2D	Abandoned
	LB2E	Abandoned
	LB6A	Abandoned
	LB6B	Abandoned
	LB6Y	Abandoned
	LB6Z	Abandoned
	LB3A	Abandoned
	LB3B	Abandoned
	LB4A	Abandoned
	LB4B	Abandoned
	LB7Y	Abandoned

Table B.2. Nonconventional Borings Inventory (Continued)

Project Installed	ID	Status
WAG 3	004-009PZ	No Evidence of PZ Found
	004-033PZ	
	004-035PZ	
	004-036PZ	
	004-037PZ	
	004-045 PZ	
	005-016PZ	
	006-017PZ	
	006-018PZ	
	006-028PZ	
	006-029PZ	
WAG 6	011-008	Abandoned
	026-002	
	040-001	
	047-001	
	203-001	
	400-003	
	400-016	
	400-017	
	400-021	
	400-022	
	400-025	
	400-026	
	400-027	
	400-030	
	400-031	
	400-033	
	400-063	
	400-083	
WAG 22, SWMUs 2 & 3	SWMU 2-3 (20’)	No Evidence of PZ Found
	SWMU 2-5 (20’)	
	SWMU 2-8 (10’)	
	SWMU 2-10 (10’)	
	SWMU 2-16 (20’)	
	SWMU 2-17 (10’)	
	SWMU 2-17 (20’)	
WAG 22, SWMUs 7 & 30	GWS-1	No Evidence of PZ Found
	GWS-2	
	WLM-1	
	WLM-2	
	WLM-5	

Table B.2. Nonconventional Borings Inventory (Continued)

Project Installed	ID	Status
WAG 27	PZ1/720-012	Present
	PZ-2/720-013	
	PZ-3/720-015	
	PZ-4/720-017	
	PZ-5/720-019	
WDA Temp PZs	5A-1	Present
	5A-2	
	5A-3	
	5A-4	
	5A-5	
	5A-6	
	5A-7	
	5A-8	
	5A-9	
	5A-10	
	11-1 (T1-1)	Present
	11-2 (T1-2)	Abandoned*
	11-3 (T1-3)	Present
	11-4 (T2-1)	
	11-5 (T2-2)	
	11-6 (T2-3)	
	11-7 (T3-1)	
	11-8 (T3-2)	
	11-9 (T3-3)	

*PZ was installed at a shallow depth (~ 2 ft). Entire PZ was located in creek bed, and the PZ is considered abandoned due to the location of the PZ in the creek bed and due to shallow depth.

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WATER LEVELS

Water level measurements are divided into two programs: (1) measurement of water levels at wells that support potentiometric surface map development in relation to the permitted landfills (measured quarterly as indicated on page B-26); and (2) measurement of water levels at the remaining wells (measured quarterly). The remaining wells are defined as those remaining wells from Appendix B of this Environmental Monitoring Plan. Wells associated with the potentiometric surface maps at the permitted landfills are measured within as short a time period as possible, not to exceed a three-day period. (Note: Wells denoted as "commitment wells" are those wells formally agreed upon to be measured, but are not listed specifically in the permit. Wells denoted as "noncommitment wells" are measured as a best management practice.) In support of the Groundwater Strategy project and groundwater modeling at the site, the annual synoptic water level event is being changed to quarterly for FY 2020. Also in support of the Groundwater Strategy project, water level measurements will be collected from Metropolis Lake at the same time as the quarterly synoptic water level events.

An investigation is being performed under the Groundwater Strategy project to evaluate the extent of trichloroethene and groundwater flow trends at the site. Manual water level measurements and measurements of data loggers/pressure transducers along with implemting colloidal borescopes will be used to measure the potentiometric surface and seasonal changes in the potentiometric surface. MWs to be evaluated under this project are included in a table on page B-28.

Water Levels in Support of Permitted Landfills

C-404 Landfill Wells Quarterly Water Levels (9)
MW84A
MW85
MW87A
MW88
MW90A
MW91A
MW93A
MW94
MW420
Commitment Wells (7) [a]
MW67
MW76
MW227
MW333
MW337
MW414
MW416
Noncommitment Wells (10)
MW86
MW89
MW92
MW95A
MW226
MW338
MW415
MW417
MW548
MW549

C-746-U Landfill Wells Quarterly Water Levels (21)	
MW357	MW368
MW358	MW369 [b]
MW359	MW370 [b]
MW360	MW371
MW361	MW372 [b]
MW362	MW373 [b]
MW363	MW374
MW364	MW375
MW365	MW376
MW366	MW377
MW367	
Noncommitment Wells (9)	
MW 98	MW173
MW100	MW193
MW125	MW197
MW139	MW200
MW165A	

C-746-S&T Landfills Wells Quarterly Water Levels (25)
MW220
MW221
MW222
MW223
MW224
MW225 [c]
MW353 [c]
MW384
MW385
MW386
MW387
MW388
MW389
MW390
MW391
MW392
MW393
MW394
MW395
MW396
MW397
MW369 [b]
MW370 [b]
MW372 [b]
MW373 [b]
Noncommitment Wells (2)
MW418
MW419

[a] Per a DOE commitment, PPPO-02-640-08, (pertaining to C-404 Landfill permitting process) water level measurements will be taken for seven additional wells that were not cited within the permit within a 24 hour window of when water level measurements are collected on the C-404 wells cited in the permit. Although these wells are not identified in the permit, the obtained water level measurement data will be reported to Kentucky Division of Waste Management as part of the semiannual report.

[b] Wells are cited in the Solid Waste Landfill Permit for C-746-S&T and C-746-U Landfills.

[c] Based on the approved permit on for the C-746-S&T Landfills, these two wells are cited in the permit; however, the permit only requires water level measurements for these wells.

Water Levels In Support of
Northeast Plume Optimization
Hydraulic Monitoring

Monitoring Wells (37)
MW145
MW155
MW163
MW165A
MW200
MW205
MW255
MW256
MW258
MW260
MW288
MW292
MW341
MW355
MW480
MW495
MW496
MW524
MW525
MW526
MW528
MW529
MW530
MW531
MW533
MW537
MW539
MW556
PZ110
MW532 (PZ)
MW534 (PZ)
MW535 (PZ)
MW540 (PZ)
MW541 (PZ)
MW553 (PZ)
MW554 (PZ)
MW555 (PZ)

Monitoring Wells Planned For Colloidal Borescope and Pressure Transducer Deployment

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW20 (also R4)	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW63			M1			M1			M1			M1
MW65			M1			M1			M1			M1
MW66			M1			M1			M1			M1
MW67			M1			M1			M1			M1
MW68			M1			M1			M1			M1
MW71	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW72			M1			M1			M1			M1
MW73			M1			M1			M1			M1
MW76			M1			M1			M1			M1
MW77 (PZ)			M1			M1			M1			M1
MW78			M1			M1			M1			M1
MW79			M1			M1			M1			M1
MW80			M1			M1			M1			M1
MW81			M1			M1			M1			M1
MW84			M1			M1			M1			M1
MW86			M1			M1			M1			M1
MW87			M1			M1			M1			M1
MW89			M1			M1			M1			M1
MW90A			M1			M1			M1			M1
MW92			M1			M1			M1			M1
MW93			M1			M1			M1			M1
MW95A			M1			M1			M1			M1
MW98			M1			M1			M1			M1
MW99	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1
MW100	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW102			M1			M1			M1			M1
MW103			M1			M1			M1			M1
MW106A	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW108			M1			M1			M1			M1
MW120			M1			M1			M1			M1
MW121	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW122			M1			M1			M1			M1
MW123			M1			M1			M1			M1
MW124			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW125			M1			M1			M1			M1
MW126	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW132	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW133			M1			M1			M1			M1
MW134	PT+M2	CB+PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2
MW135	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW137	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW139	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW144			M1			M1			M1			M1
MW145	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW146			M1			M1			M1			M1
MW147	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW148	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW150	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW152*	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW155			M1			M1			M1			M1
MW156			M1			M1			M1			M1
MW161			M1			M1			M1			M1
MW163			M1			M1			M1			M1
MW165A			M1			M1			M1			M1
MW168			M1			M1			M1			M1
MW169			M1			M1			M1			M1
MW173			M1			M1			M1			M1
MW175			M1			M1			M1			M1
MW178			M1			M1			M1			M1
MW185			M1			M1			M1			M1
MW188			M1			M1			M1			M1
MW191	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW193	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW194	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2	CB+M2	M2
MW197			M1			M1			M1			M1
MW199	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW200			M1			M1			M1			M1
MW201	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW202	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW203			M1			M1			M1			M1
MW205			M1			M1			M1			M1
MW220			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW221			M1			M1			M1			M1
MW222			M1			M1			M1			M1
MW223			M1			M1			M1			M1
MW224			M1			M1			M1			M1
MW225			M1			M1			M1			M1
MW226			M1			M1			M1			M1
MW227			M1			M1			M1			M1
MW233			M1			M1			M1			M1
MW236			M1			M1			M1			M1
MW238			M1			M1			M1			M1
MW239			M1			M1			M1			M1
MW240			M1			M1			M1			M1
MW241A			M1			M1			M1			M1
MW242			M1			M1			M1			M1
MW243			M1			M1			M1			M1
MW244			M1			M1			M1			M1
MW245			M1			M1			M1			M1
MW247			M1			M1			M1			M1
MW248			M1			M1			M1			M1
MW249			M1			M1			M1			M1
MW250			M1			M1			M1			M1
MW252	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1
MW253A	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW255			M1			M1			M1			M1
MW256			M1			M1			M1			M1
MW257			M1			M1			M1			M1
MW258			M1			M1			M1			M1
MW260			M1			M1			M1			M1
MW261			M1			M1			M1			M1
MW262	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW283			M1			M1			M1			M1
MW284			M1			M1			M1			M1
MW288			M1			M1			M1			M1
MW291	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW292			M1			M1			M1			M1
MW293A			M1			M1			M1			M1
MW294A			M1			M1			M1			M1
MW325			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW326			M1			M1			M1			M1
MW327			M1			M1			M1			M1
MW328			M1			M1			M1			M1
MW329	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	PT+M2	CB+PT+M2
MW330			M1			M1			M1			M1
MW333			M1			M1			M1			M1
MW337			M1			M1			M1			M1
MW338			M1			M1			M1			M1
MW339			M1			M1			M1			M1
MW340			M1			M1			M1			M1
MW341			M1			M1			M1			M1
MW342			M1			M1			M1			M1
MW343			M1			M1			M1			M1
MW345			M1			M1			M1			M1
MW346			M1			M1			M1			M1
MW347			M1			M1			M1			M1
MW353	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW354	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2
MW355			M1			M1			M1			M1
MW356			M1			M1			M1			M1
MW357			M1			M1			M1			M1
MW358			M1			M1			M1			M1
MW360			M1			M1			M1			M1
MW361			M1			M1			M1			M1
MW363			M1			M1			M1			M1
MW364			M1			M1			M1			M1
MW366	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW367			M1			M1			M1			M1
MW369			M1			M1			M1			M1
MW370			M1			M1			M1			M1
MW372			M1			M1			M1			M1
MW373			M1			M1			M1			M1
MW376			M1			M1			M1			M1
MW380			M1			M1			M1			M1
MW381			M1			M1			M1			M1
MW384			M1			M1			M1			M1
MW385			M1			M1			M1			M1
MW387			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW388			M1			M1			M1			M1
MW391			M1			M1			M1			M1
MW392			M1			M1			M1			M1
MW394	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW395			M1			M1			M1			M1
MW397			M1			M1			M1			M1
MW401			M1			M1			M1			M1
MW402			M1			M1			M1			M1
MW409	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW410	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	CB+PT+M1	PT+M1	PT+M1
MW411	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW414			M1			M1			M1			M1
MW415			M1			M1			M1			M1
MW416			M1			M1			M1			M1
MW417			M1			M1			M1			M1
MW418	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW419			M1			M1			M1			M1
MW420			M1			M1			M1			M1
MW421			M1			M1			M1			M1
MW422			M1			M1			M1			M1
MW423			M1			M1			M1			M1
MW424			M1			M1			M1			M1
MW425			M1			M1			M1			M1
MW426	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2	PT+M2	CB+PT+M2	PT+M2
MW427	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2
MW428	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2	M2	M2	CB+M2
MW429 A	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2
MW430	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2
MW431	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW432	M2	M2	M2	CB+M2	M2	M2	M2	M2	M2	CB+M2	M2	M2
MW433			M1			M1			M1			M1
MW435			M1			M1			M1			M1
MW439			M1			M1			M1			M1
MW440			M1			M1			M1			M1
MW441			M1			M1			M1			M1
MW442			M1			M1			M1			M1
MW443			M1			M1			M1			M1
MW444			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW445	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW447			M1			M1			M1			M1
MW448			M1			M1			M1			M1
MW450			M1			M1			M1			M1
MW451			M1			M1			M1			M1
MW452			M1			M1			M1			M1
MW453			M1			M1			M1			M1
MW454			M1			M1			M1			M1
MW455			M1			M1			M1			M1
MW456			M1			M1			M1			M1
MW457			M1			M1			M1			M1
MW458			M1			M1			M1			M1
MW459	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW460			M1			M1			M1			M1
MW461			M1			M1			M1			M1
MW462			M1			M1			M1			M1
MW463	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW464	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW465	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1
MW466	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1
MW467	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW468	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW469	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1
MW470	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1	M1	M1
MW471	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW472	M1	CB+M1	M1	CB+M1	M1	M1	M1	CB+M1	M1	CB+M1	M1	M1
MW473	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1
MW474	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW475	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW476	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1
MW477	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1
MW478			M1			M1			M1			M1
MW479			M1			M1			M1			M1
MW480			M1			M1			M1			M1
MW481	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW482	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW483	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW484	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW485	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW486A	M1	M1	M1	M1	M1	CB+M1	M1	M1	M1	M1	M1	CB+M1
MW487	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW488	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	CB+PT+M1	PT+M1	PT+M1	PT+M1
MW489			M1			M1			M1			M1
MW490			M1			M1			M1			M1
MW491	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1	PT+M1
MW492			M1			M1			M1			M1
MW493			M1			M1			M1			M1
MW494			M1			M1			M1			M1
MW495			M1			M1			M1			M1
MW496	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
MW497			M1			M1			M1			M1
MW498			M1			M1			M1			M1
MW499			M1			M1			M1			M1
MW500			M1			M1			M1			M1
MW501			M1			M1			M1			M1
MW502			M1			M1			M1			M1
MW503			M1			M1			M1			M1
MW504			M1			M1			M1			M1
MW505			M1			M1			M1			M1
MW506			M1			M1			M1			M1
MW507			M1			M1			M1			M1
MW524			PT+M1			M1			M1			M1
MW525			M1			CB+PT+M1			M1			M1
MW526			M1			M1			CB+PT+M1			M1
MW527			CB+PT+M1			M1			M1			M1
MW528			M1			M1			M1			M1
MW529			M1			PT+M1			M1			M1
MW530			M1			M1			PT+M1			M1
MW531			M1			M1			M1			M1
MW532 (PZ)			M1			M1			M1			M1
MW533			M1			M1			M1			M1
MW534 (PZ)			M1			M1			M1			M1
MW535 (PZ)			M1			M1			M1			M1
MW536			M1			M1			M1			M1
MW537			M1			M1			M1			M1
MW538			M1			M1			M1			M1

Monitoring Wells Planned for Colloidal Borescope and Pressure Transducer Deployment (Continued)

Well Number	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12
MW539			M1			M1			M1			M1
MW540 (PZ)			M1			M1			M1			M1
MW541 (PZ)			M1			M1			M1			M1
MW542			M1			M1			M1			M1
MW543			M1			M1			M1			M1
MW544			M1			M1			M1			M1
MW545			M1			M1			M1			M1
MW546			M1			M1			M1			M1
MW547			M1			M1			M1			M1
MW548			M1			M1			M1			M1
MW549			M1			M1			M1			M1
MW550			M1			M1			M1			M1
MW551			M1			M1			M1			M1
MW553 (PZ)			M1			M1			M1			M1
MW554 (PZ)			M1			M1			M1			M1
MW555 (PZ)			M1			M1			M1			M1
MW556			M1			M1			M1			M1
PZ107			M1			M1			M1			M1
PZ109			M1			M1			M1			M1
PZ110			M1			M1			M1			M1
PZ114			M1			M1			M1			M1
PZ115			M1			M1			M1			M1
PZ117			M1			M1			M1			M1
PZ118			M1			M1			M1			M1
PZ287			M1			M1			M1			M1
PZ289			M1			M1			M1			M1
PZ290			M1			M1			M1			M1
PZ349			M1			M1			M1			M1
PZ351			M1			M1			M1			M1
EW232			M1			M1			M1			M1
EW233			M1			M1			M1			M1
EW234			M1			M1			M1			M1
EW235			M1			M1			M1			M1

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
*MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583.

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APPENDIX C

ENVIRONMENTAL SAMPLING FREQUENCY AND PARAMETERS

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ACRONYMS

ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CY	calendar year
DOE	U.S. Department of Energy
EM	environmental monitoring
EMP	Environmental Monitoring Plan
ERPP	Environmental Radiation Protection Program
FFA	Federal Facility Agreement
FPDP	Fluor Federal Services, Inc., Paducah Deactivation Project
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
MCL	maximum contaminant level
MW	monitoring well
PGDP	Paducah Gaseous Diffusion Plant
RFI	Resource Conservation and Recovery Act Facility Investigation
ROD	record of decision
TSS	total suspended solids

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C.1. INTRODUCTION

Three-hundred ninety-seven monitoring wells (MWs) and piezometers are active and monitored as part of the Environmental Monitoring (EM) Program. Active wells either are in an analytical sampling program or may be evaluated only for water level measurements. This appendix shows a summary of each analytical sampling program. (Note: Wells denoted as "noncommitment wells" are measured as a best management practice, but are not listed in the permit.)

In addition to MW locations, the sampling programs within this appendix include sampling parameters for other locations covered in the EM Program (i.e., surface water and sediment programs).

Each summary includes the environmental sampling frequencies, parameters, analytical methods, the sampling drivers, rationale for conducting the sampling, which document(s) the sampling results are reported in, and a list of locations that are sampled.

An effort has been made to reduce the amount of sampling performed to support fiscal responsibility of the EM program at the site. The criteria used to determine less frequent sampling include the following:

- New understanding of contaminant migration pathways and contaminants present,
- Review of historical results and long-term trends,
- Analyses to determine if the MW meets the current and future objectives of the Groundwater Operable Unit, and
- Addition of new MWs that may eliminate the need for sampling older MWs.

A brief summary of changes that have been made from the fiscal year (FY) 2019 to the FY 2020 Environmental Monitoring Plan (EMP) is included in each sampling program section. The changes described in this appendix were made using the criteria listed above. Data collected under the sampling programs defined in this appendix will be evaluated in FY 2020. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification or via modification of the appropriate driver and reflected in the FY 2021 EMP. In those cases where sampling cannot be performed due to an uncontrollable condition, such as blocked access to an MW due to flooding conditions, the sampling staff will denote the reason as to why the sample could not be collected.

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C.2. GROUNDWATER MONITORING

The Paducah Site samples MWs and residential wells on a routine basis. Additionally, MWs are monitored for water levels on a routine basis. The EM manager is responsible for accepting any new MWs installed and assuring that the wells meet the following standards:

(1) Construction requirements, as outlined in either the statement of work, field sampling plan, or work plan for the project;

(2) Acceptance criteria for well development, as outlined in the U.S. Department of Energy's (DOE) Four Rivers Nuclear Partnership, LLC (FRNP) procedures;

(3) Requirements for pump and packer placement; and

(4) The well is functioning properly and has no deficiencies.

MWs that do not meet these requirements will not be accepted by the EM manager until all deficiencies have been corrected. More specific requirements to the acceptance of MWs are detailed in procedure CP4-ES-0069, *Monitoring Well and Associated Infrastructure Installation*. MWs are inspected, at a minimum, on an annual basis per the procedure CP4-ES-0074, *Monitoring Well Inspection and Maintenance*. Outlines for well rehabilitation methods are found in CP2-ES-0024, *Monitoring Well Maintenance Implementation Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*.

Specified methods found in Appendix C are EPA-approved methods, as applicable. In some instances, such as with radionuclides, EPA-approved methods are unavailable. For this EMP, the currently used laboratory's analytical procedure is noted as the method of choice. If an analysis is conducted at another laboratory during FY 2020, an equivalent procedure will be used upon approval by the EM manager.

C.2.1 GROUNDWATER MONITORING PROGRAM FOR LANDFILL OPERATIONS

C-746-S, C-746-T, and C-746-U Landfills (Solid Waste Landfill Monitoring)

Frequency: Quarterly

Driver: Sampling requirements are outlined in the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045 issued by the Kentucky Division of Waste Management (KDWM) and *Groundwater Monitoring Plan for the Solid Waste Permitted Landfills (C-746-S Residential Landfill, C-746-T Inert Landfill, and C-746-U Contained Landfill) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-PROJ-0139, June 2014.

Reported: Quarterly Compliance Monitoring Reports, as required by the permit, and the Annual Site Environmental Report (ASER)

Rationale: To evaluate the potential impact of historical waste disposal activities at the C-746-S&T Landfills, as well as historical and current waste disposal activities at the C-746-U Landfill on groundwater quality and to comply with compliance monitoring requirements, as set forth in the solid waste landfill permit.

Comments: For Solid Waste Landfill Permit, SW07300014, SW07300015, SW07300045, the reporting requirement for maximum contaminant level (MCL) is as follows: "If the analysis of groundwater sample results indicates contamination (i.e., a statistical or MCL exceedance)

as specified in 401 *KAR* 48:300 Section 8(1), the owner or operator shall notify the Cabinet within (forty-eight) 48 hours of receiving the results and shall arrange to split sample no later than ten (10) days from the receipt of the results. [401 *KAR* 48:300 Section 7]"

MW sampling is performed and reported collectively for the C-746-S and C-746-T Landfills. Sample collection order is as follows: volatiles (including total organic halides), dissolved gases and total organic carbon, semivolatile organics, metals and cyanide, water quality cations and anions, and radionuclides. If samples are being collected at a location where it is anticipated that sample volume is not adequate, then the order of collection will be volatiles followed by radionuclides.

Data collected under this program will be evaluated. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification and reflected in the FY 2021 EMP.

Tables C.1 and C.2 list MWs for the C-746-S, C-746-T, and C-746-U Landfills, and Table C.3 lists the quarterly analytical parameters for these landfills. Locations are shown on Figure C.1.

Table C.1. C-746-S and C-746-T Landfills Wells (23)[a]

MW220	MW370[b]	MW387	MW393
MW221	MW372[b]	MW388	MW394
MW222	MW373[b]	MW389	MW395
MW223	MW384	MW390	MW396
MW224	MW385	MW391	MW397
MW369[b]	MW386	MW392	

[a] The total number of wells cited in the permit associated with the C-746-S&T Landfills is 25; however, two of these wells (MW225, MW353) only require water level measurement. The total number of analytically measured wells, therefore, is 23.

[b] Wells are sampled with the C-746-U Landfill sampling event; these four wells are not counted in the sampling event for the C-746-S&T Landfills, but are reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills. These wells are upgradient wells for the C-746-U Landfill and are downgradient wells for the C-746-S&T Landfills.

Table C.2. C-746-U Landfill Wells (21)

MW357	MW363	MW368	MW373*
MW358	MW364	MW369*	MW374
MW359	MW365	MW370*	MW375
MW360	MW366	MW371	MW376
MW361	MW367	MW372*	MW377
MW362			

*These four wells are not counted in the totals for the C-746-S&T Landfills, but are reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills. These wells are upgradient wells for the C-746-U Landfill and are downgradient wells for the C-746-S&T Landfills.

Table C.3. C-746-S, C-746-T, C-746-U Quarterly Analytical Parameters

Volatiles—Method 8260B unless noted		
1,1,1,2-Tetrachloroethane	Acetone	Dibromochloromethane
1,1,1-Trichloroethane	Acrolein	Dibromomethane
1,1,2,2-Tetrachloroethane	Acrylonitrile	Dimethylbenzene, Total[a]
1,1,2-Trichloroethane	Benzene	Ethylbenzene
1,1-Dichloroethane	Bromochloromethane	Iodomethane
1,1-Dichloroethene	Bromodichloromethane	Methylene Chloride
1,2,3-Trichloropropane	Bromoform	Styrene
1,2-Dibromo-3-chloropropane—8011	Bromomethane	Tetrachloroethene
1,2-Dibromoethane	Carbon Disulfide	Toluene
1,2-Dichlorobenzene	Carbon Tetrachloride	*trans*-1,2-Dichloroethene
1,2-Dichloroethane	Chlorobenzene	*trans*-1,3-Dichloropropene
1,2-Dichloropropane	Chloroethane	*trans*-1,4-Dichloro-2-Butene
1,4-Dichlorobenzene	Chloroform	Trichloroethene
2-Butanone	Chloromethane	Trichlorofluoromethane
2-Hexanone	*cis*-1,2-Dichloroethene	Vinyl Acetate
4-Methyl-2-pentanone	*cis*-1,3-Dichloropropene	Vinyl Chloride
Anions—Method 9056		
Bromide	Fluoride	Sulfate
Chloride	Nitrate as Nitrogen	
Metals—Method 6020 unless noted		
Aluminum		Silver
Antimony	Iron	Sodium
Arsenic	Lead	Tantalum
Barium	Magnesium	Thallium
Beryllium	Manganese	Uranium
Boron	**Mercury—7470A**	Vanadium
Cadmium	Molybdenum	Zinc
Calcium	Nickel	Barium, Dissolved[b]
Chromium	Potassium	Chromium, Dissolved[b]
Cobalt	Rhodium	Uranium, Dissolved[b]
Copper	Selenium	
Miscellaneous—Method as follows		
Chemical Oxygen Demand—410.4	**Iodide—300.0**	**Total Dissolved Solids—160.1**
Cyanide—9012B	**Total Organic Carbon—9060A**	**Total Organic Halides—9020B**
Field Parameters		
Conductivity	Redox	Temperature
Depth to Water	pH	Turbidity
Dissolved Oxygen		
PCBs[c]—Method 8082		
PCB, Total	PCB-1232	PCB-1254
PCB-1016	PCB-1242	PCB-1260
PCB-1221	PCB-1248	PCB-1268
Radionuclides—Method as follows		
Alpha Activity—9310	**Radium-228[d]—904.0M**	**Thorium-230—Th-01-RC M**
Beta Activity—9310	**Strontium-90—905.0M**	**Thorium-232[d]—Th-01-RC M**
Radium-226—AN-1418	**Technetium-99—TC-02-RC M**	**Tritium—906.0M**

[a] Xylenes

[b] Permit does not require analysis of dissolved metals. These parameters are analyzed in support of understanding the source of contaminants potentially observed in wells in comparison to total metals.

[c] Polychlorinated biphenyls (PCBs) are required under the solid waste permits to be monitored quarterly for the C-746-U Landfill and annually for the C-746-S&T Landfills.

[d] Permit does not require analysis of radium-228 and thorium-232. These parameters are analyzed in support of demonstrating compliance with DOE Order 458.1 for the C-746-U Landfill.

Methods included in table are equivalent methods to those listed in the current *Groundwater Monitoring Plan for the Solid Waste Permitted Landfills (C-746-S Residential Landfill, C-746-T Inert Landfill, And C-746-U Contained Landfill) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-PROJ-0139.

Bolded parameters are sampled by different method than specified in header.

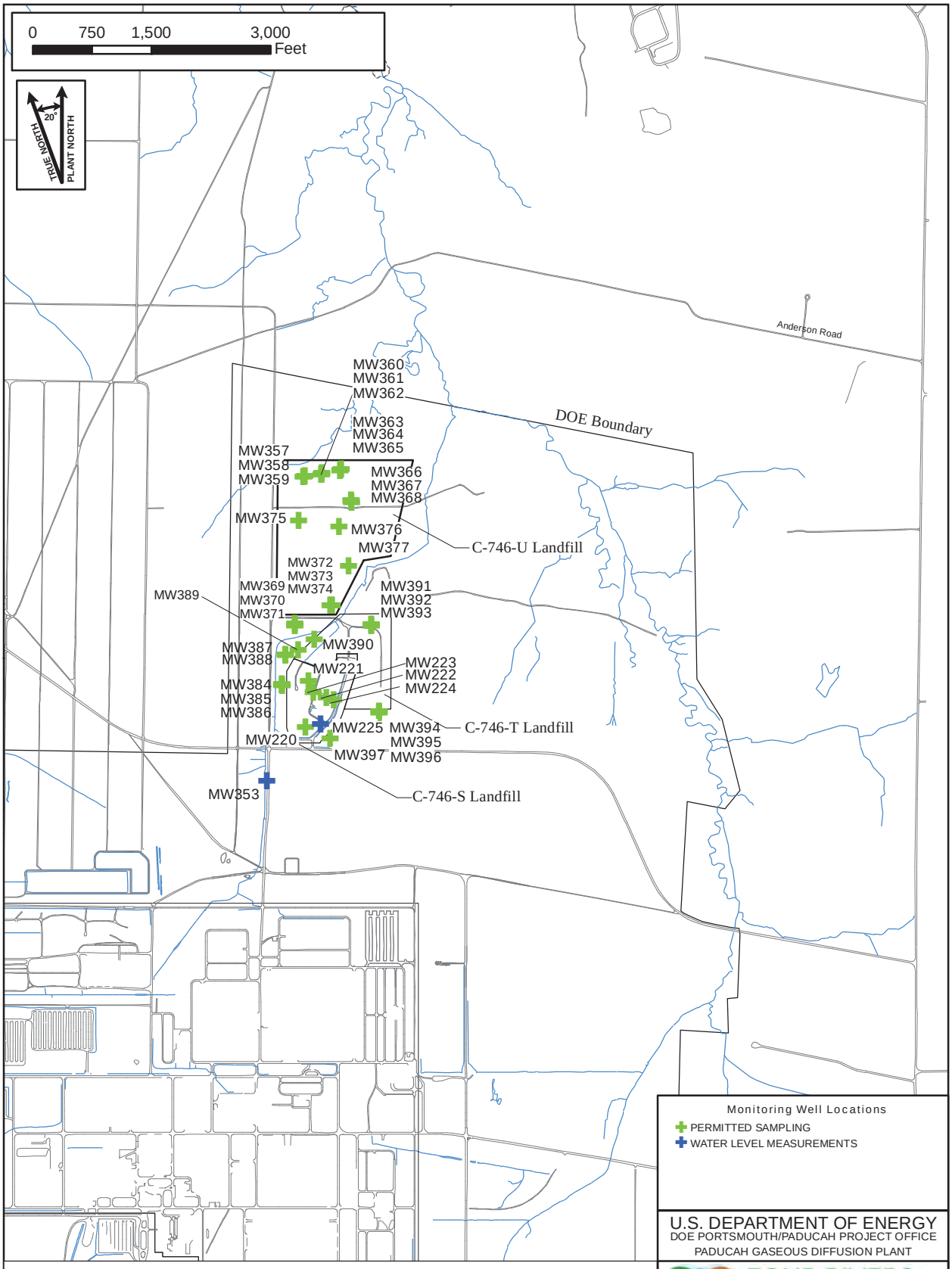

Figure C.1. Groundwater Monitoring Wells near the C-746-S, T, and U Landfills

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DATE 11-11-2016

C-404 Low-Level Radioactive Waste Burial Ground (Resource Conservation and Recovery Act Detection Status Monitoring)

Frequency: Semiannually

Driver: The semiannual parameters are required to be sampled per Hazardous Waste Management Facility Permit, KY8-890-008-982.

Reported: Semiannual C-404 Groundwater Monitoring Report required by the permit, Semiannual Federal Facility Agreement (FFA) Progress Report, and the ASER

Rationale: To monitor the C-404 Low-Level Radioactive Waste Burial Ground under detection monitoring program regulations.

Rule: Determine, within 30 days of the completion of data validation, if there is a statistical increase over background for permit parameters using the Analysis of Variance method. If there is an increase, then evaluate if the contamination is from the C-404 Landfill or another source. If another source is the cause of the contamination, then a notification must be submitted to KDWM within 7 days.

Comments: In the event that only a partial sample can be obtained, the following priority will be followed: field parameters, trichloroethene (TCE), and metals. The dissolved metal samples (arsenic, cadmium, chromium, lead, mercury, selenium, and uranium) are filtered at the off-site laboratory.

In support of an alternate source demonstration at the C-404 Landfill, additional metals analysis are performed on some MWs that are not required to be sampled under the landfill permit issued by KDWM. Additionally, sulfate analysis is performed on the C-404 Landfill MWs. The sulfate analysis provides key information to assess the significance of biological activity and abiotic processes in the wells. The data will be evaluated, and any necessary changes to the monitoring will be reflected in the FY 2021 EMP.

A source demonstration conducted for MW87 concluded that corrosion had compromised the integrity of the well over its 30-year service life. The integrity of the well was determined to have deteriorated to a point that it no longer was suitable for its intended purpose; therefore, MW87 was abandoned and replaced. MW84 and MW93, which are the same age (installed in 1988) as MW87, also were abandoned and replaced. MW84, MW87, and MW93 were replaced with MW84A, MW87A, and MW93A.

Field parameters (pH, temperature, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity) are measured using a Hydrolab water quality meter. Other field parameters, such as depth to water and barometric pressure, are measured prior to sampling.

Prior to sample collection, KDWM shall be notified one week in advance. Notification may be made in writing or electronic format. Electronic mail shall be submitted to pertinent KDWM field personnel.

Data collected under this program will be evaluated. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification and reflected in the FY 2021 EMP.

A listing of MWs for the C-404 Landfill is presented in Table C.4 and the analytical parameters are presented in Table C.5. Locations are shown on Figure C.2.

Table C.4. C-404 Landfill Wells

C-404 Landfill Wells (9)			
MW84A	MW88	MW91A	MW94
MW85	MW90A	MW93A	MW420
MW87A			
Noncommitment Wells (12)[a]			
TCE, Tc-99, and Field Parameters			
MW67	MW89	MW226	MW337
MW76	MW92	MW227	MW338
MW86	MW95A	MW333	MW548[b]
Noncommitment Wells (7)			
Metals and Field Parameters			
MW227	MW414	MW549	MW551
MW333	MW416	MW550	

[a] Routine sampling of these wells is not required by the permit. MWs 414 and 416 are also part of this special sampling event; however, only depth to water measurements are collected for these two wells.
[b] MW548 was installed during Phase V of Solid Waste Management Unit (SWMU) 4 and is intended to serve as a complementary well to MW333 in order to detect trends for TCE in the RGA near the C-404 Landfill.

Table C.5. C-404 Landfill Semiannual Analytical Parameters

Volatiles—Method 8260B			
Trichloroethene			
Metals—6020 unless noted			
Arsenic	Lead	Uranium	Lead, Dissolved*
Cadmium	Manganese*	Arsenic, Dissolved*	**Mercury, Dissolved—7470A***
Chromium	**Mercury—7470A**	Cadmium, Dissolved*	Selenium, Dissolved*
Iron*	Selenium	Chromium, Dissolved*	Uranium, Dissolved*
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity
Radionuclides—Method U-02-RC M unless noted			
Technetium-99—TC-02-RC M	Uranium-234	Uranium-235	Uranium-238
Miscellaneous			
Total Organic Carbon—9060*	**Sulfate—9056***		

*Not required by the permit.
Bolded parameters are sampled by different method than specified in header.
Alternate SW-846 methods may be substituted with prior written approval from KDWM.

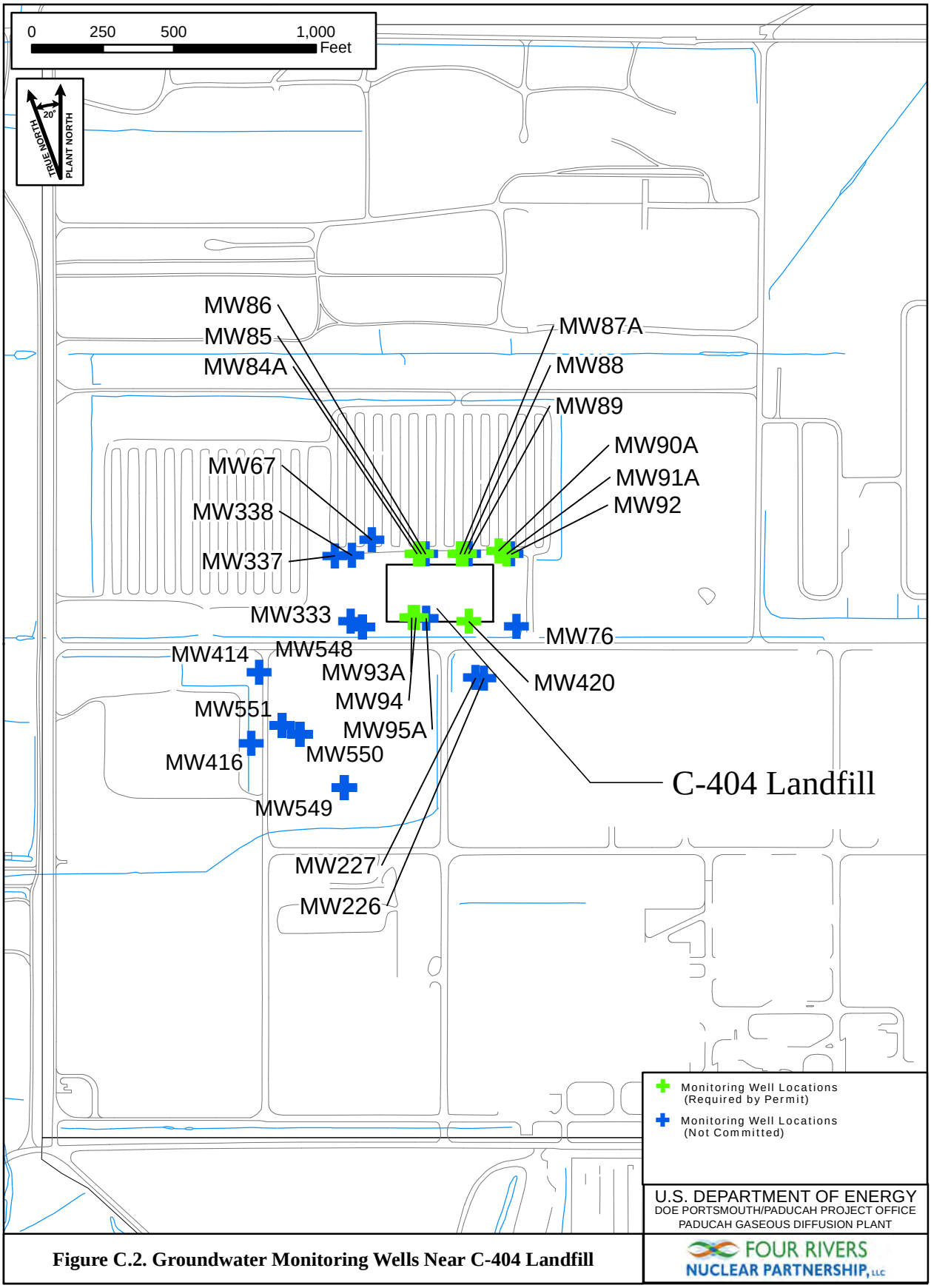

Figure C.2. Groundwater Monitoring Wells Near C-404 Landfill

C-746-K Landfill Monitoring

Frequency: Semiannually

Driver: *Record of Decision for Waste Area Groups 1 and 7 for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D2, September 1997: Even though the Record of Decision (ROD) for Waste Area Groups 1 and 7 was a Surface Water Operable Unit decision document, sampling of MWs is noted in the ROD. The ROD also allows for annual evaluation of the program with documentation in the *Sampling and Analysis Plan Addendum*, KY/ER-2, which previously was superseded by the EMP.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: To evaluate the potential impact of historical waste disposal activities at the C-746-K Landfill on groundwater quality.

Comments: In the event a well becomes dry while purging, no sample will be taken; however, it should be recorded that no sample was collected because the well was dry. Starting in 2005, the frequency was reduced from quarterly to semiannually.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2020.

Tables C.6 and C.7 provide a listing of landfill wells and analytical parameters, respectively. Locations are shown on Figure C.3.

Table C.6. C-746-K Landfill Wells (3)

MW300	MW302	MW344

Table C.7. C-746-K Landfill Semiannual Analytical Parameters

Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			
Field Parameters			
Conductivity	Ferrous Iron (Fe^{+2})	pH	Turbidity
Barometric Pressure	Depth to Water	Temperature	Redox
	Dissolved Oxygen		
Miscellaneous—310.1			
Alkalinity			
Metals—Method 6020			
Barium, Dissolved	Uranium, Dissolved	Cadmium	Manganese
Beryllium, Dissolved	Aluminum	Calcium	Nickel
Cadmium, Dissolved	Arsenic	Iron	Potassium
Lead, Dissolved	Barium	Lead	Sodium
Arsenic, Dissolved	Beryllium	Magnesium	Uranium
Radionuclides—Method 9310 unless noted			
Alpha Activity	Beta Activity	**Technetium-99—TC-02-RC M**	
Anions—Method 9056			
Chloride	Sulfate	Nitrate	

*Xylenes
Bolded parameters are sampled by different method than specified in header.

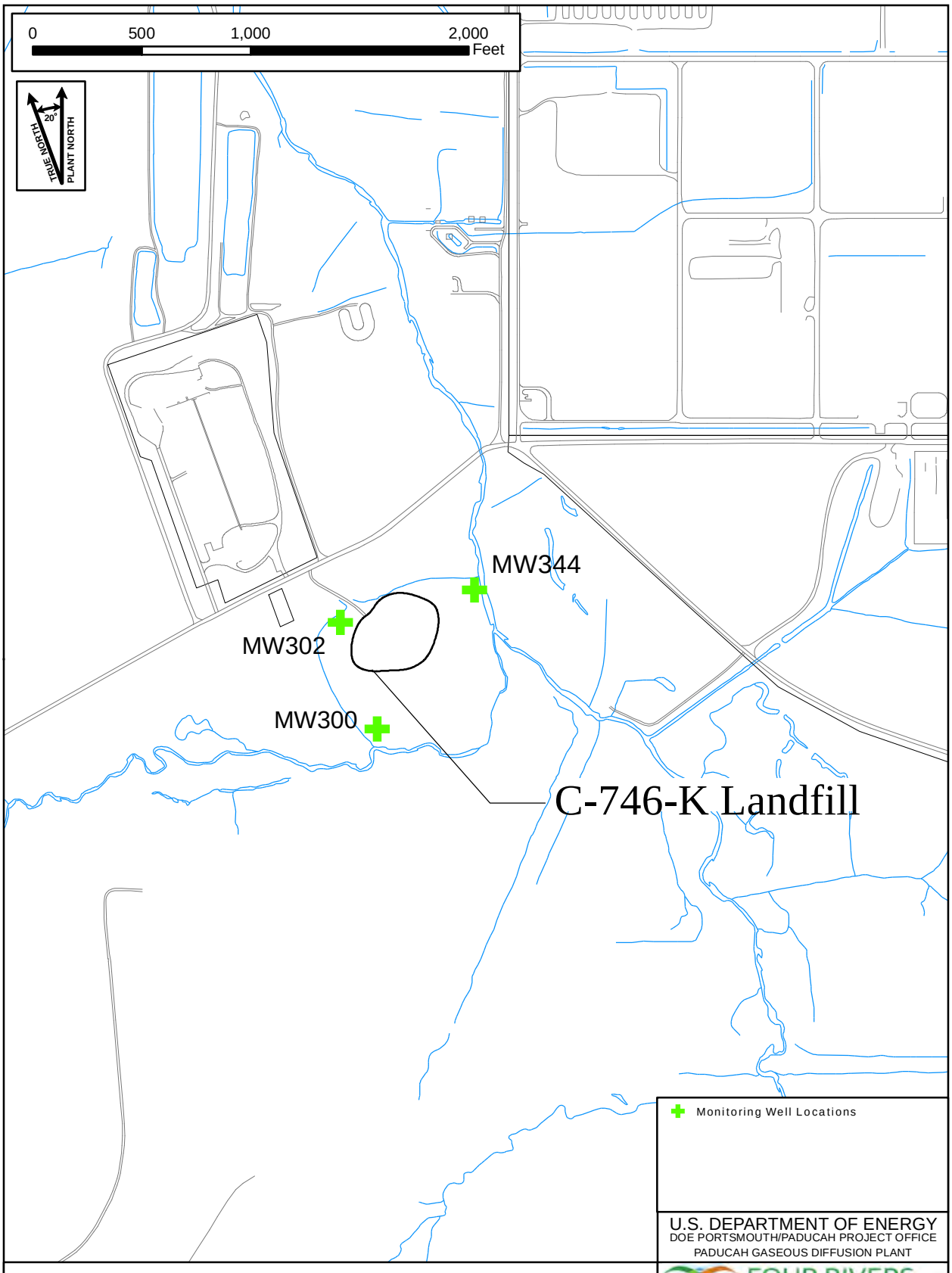

Figure C.3. Groundwater Monitoring Wells near C-746-K Landfill

C.2.2 NORTHEAST PLUME OPERATIONS AND MAINTENANCE PROGRAM

Northeast Plume Monitoring

Frequency: Quarterly

Driver: The MWs are required to be sampled by the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1535&D3/R6, September 2017, and by the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2/R3/A1, July 2018.

Reported: Semiannual FFA Progress Report and ASER

Rationale: To monitor the nature and extent of groundwater contamination and to evaluate any trends in water quality that may affect contaminant migration.

Comments: The extraction wells (EWs) (or other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan for the Northeast Plume.

The Northeast Plume EW system has undergone an optimization. New EWs have been installed in new locations closer to the site due to the decreasing concentration of contaminants at their current locations. This optimization program included two new EWs, EW234 and EW235, and 22 piezometers and MWs. Sampling frequencies and sampling parameters required by the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1535&D3/R6, September 2017, and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2/R3/A1, July 2018, are included in Table C.8. The EWs (and other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan listed above for the Northeast Plume. Locations are shown on Figure C.4.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2020.

Table C.8. Northeast Plume Optimization Quarterly Wells and Parameters

Quarterly Wells (36)			
MW124	MW126	MW144	MW145
MW155	MW156	MW163	MW255[a]
MW256[a]	MW258	MW260	MW283
MW288	MW291	MW292	MW293A
MW341	MW478	MW479	MW480
MW495	MW496	MW524	MW525
MW526	MW527	MW528	MW529
MW530	MW531	MW533	MW536
MW537	MW538	MW539	MW556
Quarterly Analytical Parameters			
Volatiles—Method 8260B			
1,1-Dichloroethene	Trichloroethene		
Radionuclides—Method TC-02-RC M			
Technetium-99			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

[a] Northeast Plume Operations and Maintenance plan requires semiannual sampling of MW255 and MW256; however, these wells are sampled more frequently (quarterly) to provide timely assessment of Northeast Plume optimized extraction well operations.

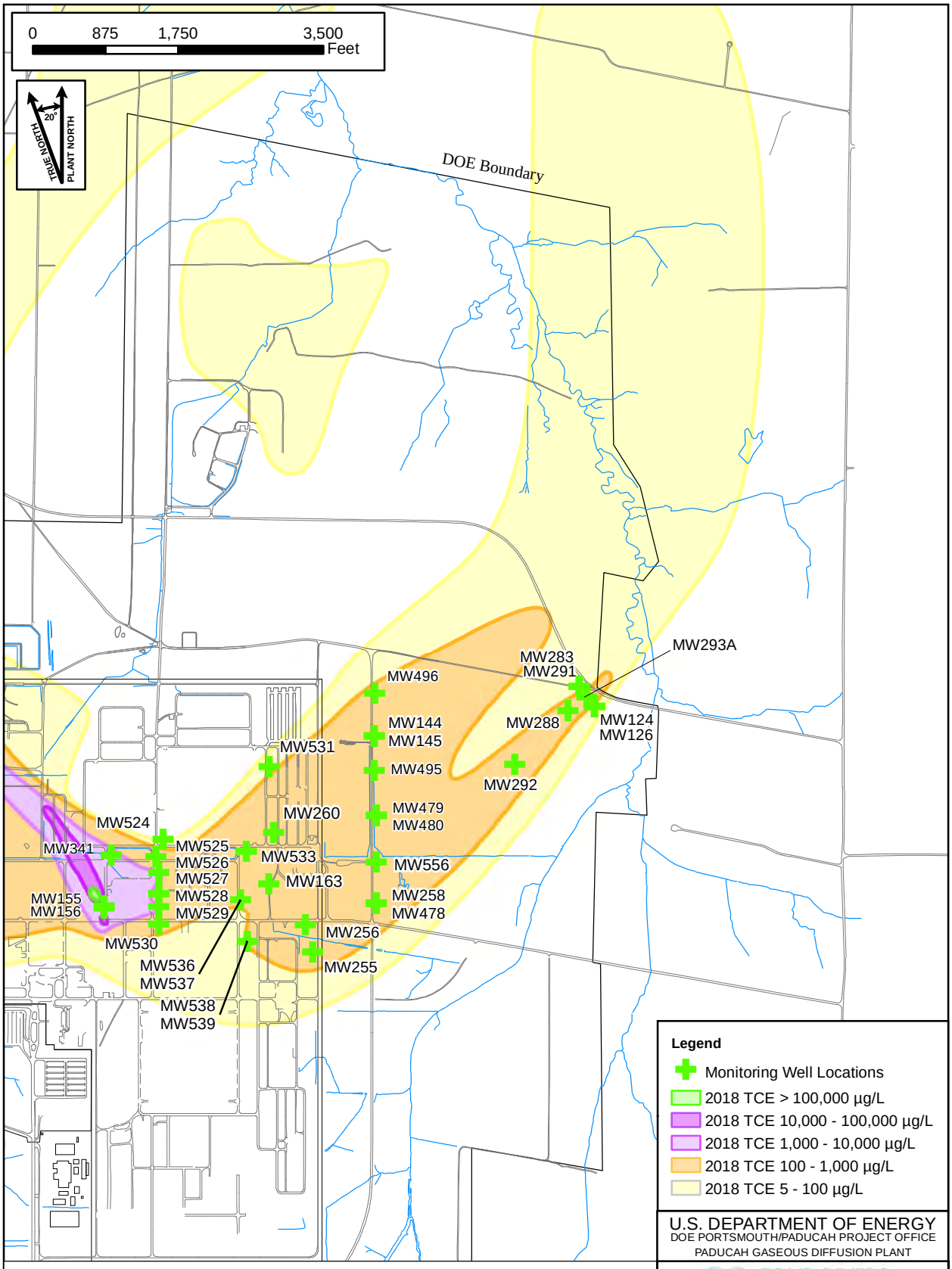

Figure C.4. Northeast Plume Monitoring Wells

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8/21/2019

C.2.3 NORTHWEST PLUME OPERATIONS AND MAINTENANCE PROGRAM

Northwest Plume Monitoring

Frequency: Quarterly and Semiannually

Driver: The MWs are required to be sampled by the *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1253&D4/R5, September 2010.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: To determine the effectiveness of the optimization of Northwest Plume operations, monitor the nature and extent of groundwater contamination, and evaluate any trends in water quality that may affect contaminant migration.

Comments: The extraction wells (or other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan for the Northwest Plume.

The sampling frequency for MW460 within the Operations and Maintenance Plan is semiannual; however, the frequency of sampling was increased to quarterly in FY 2018 in order to evaluate trends in TCE concentrations along the Northwest Plume.

Sampling frequencies and parameters were not modified for this sampling program for FY 2020.

Table C.9 provides a listing of MWs, and Table C.10 provides the analytical parameters for these MWs. Locations are shown on Figure C.5.

Table C.9. Northwest Plume Wells

Semiannual Wells (32)					
MW63	MW243	MW340	MW456	MW497	MW503
MW65	MW244	MW355	MW457	MW498	MW504
MW66	MW245	MW428	MW458	MW499	
MW165A	MW248	MW429A	MW459	MW500	
MW173	MW250	MW430	MW461	MW501	
MW242	MW339	MW455	MW462	MW502	
Quarterly Well (1)					
MW460					

Table C.10. Northwest Plume Analytical Parameters

Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity
Radionuclides—Method 9310 unless noted			
Alpha Activity	Beta Activity	**Technetium-99—TC-02-RC M**	

*Xylenes
Bolded parameters are sampled by different method than specified in header.

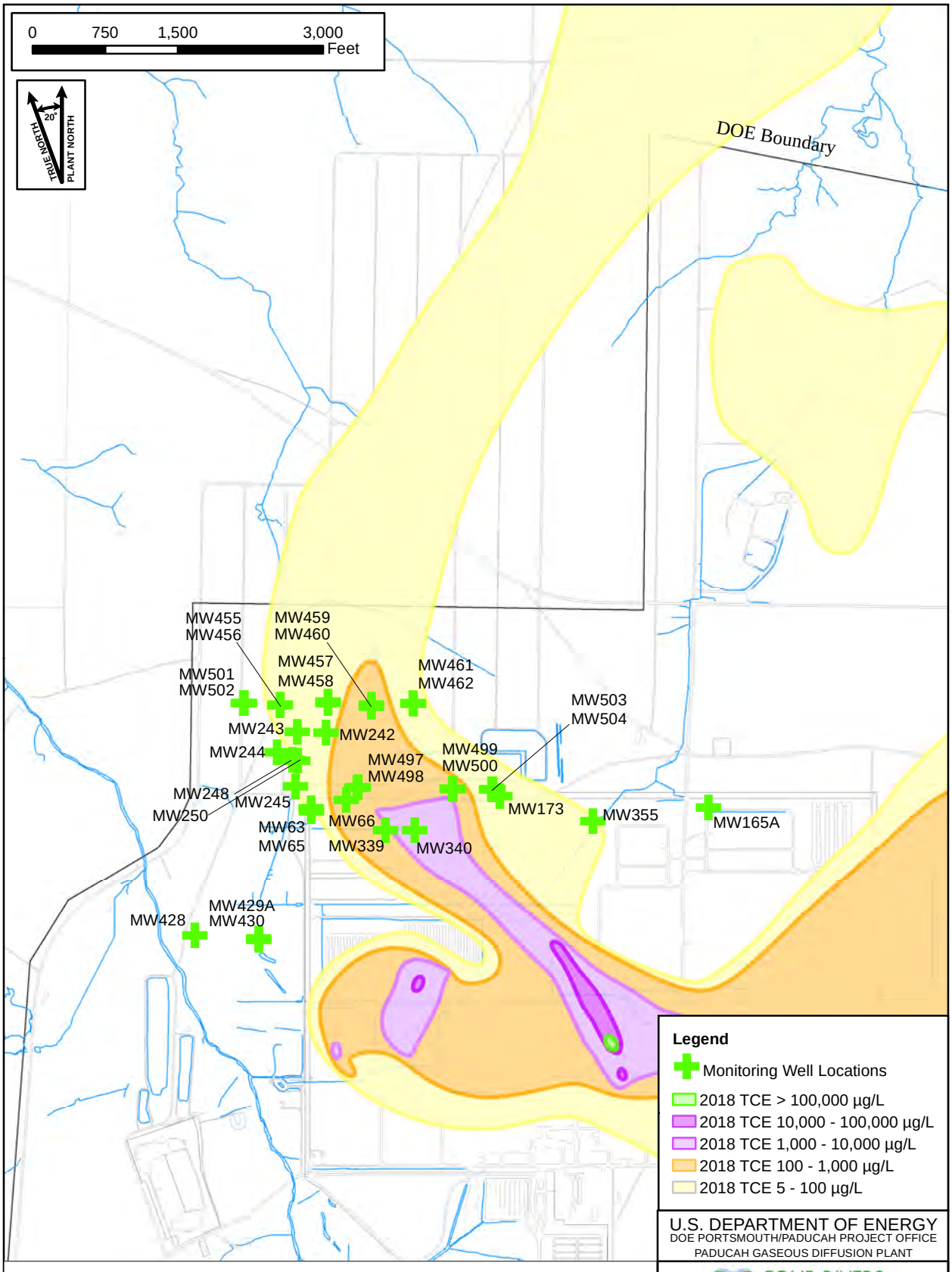

Figure C.5. Northwest Plume Monitoring Wells

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9/25/2019

C.2.4 C-400 MONITORING WELLS

C-400 Wells

Frequency: Quarterly and Semiannually

Driver: MWs are required to be sampled by the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2150&D2/R2, July 2005.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: These MWs will provide a meaningful tool for evaluating the downgradient dissolved-phase contamination in the Northwest Plume and the efficacy of the C-400 Interim Remedial Action.

Comments: MW178 and MW341 were added to the quarterly sampling event in support of the C-400 Remedial Investigation.

In support of the C-400 Remedial Investigation/Feasibility Study, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5 will be sampled for PCBs and PAHs in FY 2020.

Table C.11 provides a listing of the C-400 MWs, and Table C.12 provides the analytical parameters for these MWs. Locations are shown on Figure C.6.

Table C.11. C-400 Monitoring Wells (19)

Quarterly Wells (11)		
MW155	MW405: Port 5[b]	MW505[a]
MW156	MW406: Port 5[b]	MW506[a]
MW178	MW407: Port 4[b]	MW507[a]
MW341	MW408: Port 5[b]	
Semiannual Wells (8)		
MW175	MW421: Port 1, Port 2, Port 3	MW424: Port 1, Port 2, Port 3
MW342	MW422: Port 1, Port 2, Port 3	MW425: Port 1, Port 2, Port 3
MW343	MW423: Port 1, Port 2, Port 3	

[a] MW68 and MW71 will be sampled under the Annual Environmental Surveillance sampling program, but will be sampled at the same time as these wells during the second quarter of the calendar year (CY).
[b] These wells will be sampled for PCBs and PAHs along with the other analytical parameters.

Table C.12. C-400 Monitoring Wells Analytical Parameters

Volatiles—Method 8260B			
1,1-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl Chloride
cis-1,2-Dichloroethene			
Anions—Method 9056			
Chloride			
PCBs—Method 8082			
PCB, Total	PCB-1221	PCB-1242	PCB-1254
PCB-1016	PCB-1232	PCB-1248	PCB-1260
PAHs—Method 8270D			
Benz(a)anthracene	Benzo(b)fluoranthene	Chrysene	Indeno(1,2,3-cd)pyrene
Benzo(a)pyrene	Benzo(k)fluoranthene	Dibenz(a,h)anthracene	
Radionuclides—Method TC-02-RC M			
Technetium-99			
Field Parameters			
Barometric Pressure	Depth to Water[a]	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

[a] As applicable, depth to water measurements cannot be obtained for multiport wells.

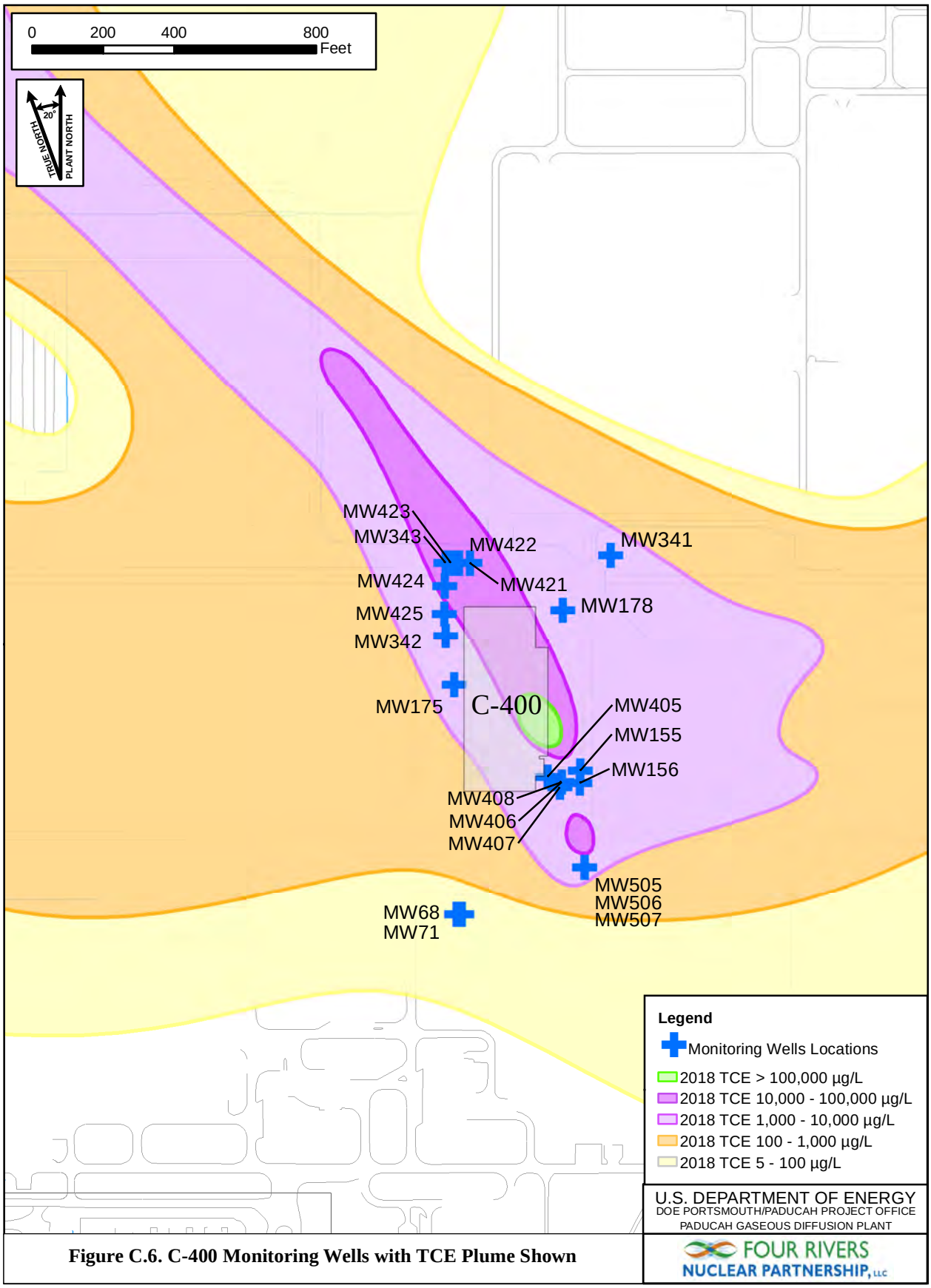

Figure C.6. C-400 Monitoring Wells with TCE Plume Shown

C.2.5 SWMU 1 MONITORING WELLS

SWMU 1 Wells

Frequency: Semiannually

Driver: The MWs are required to be sampled by the *Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1287&D2, December 2013.

Reported: ASER

Rationale: To monitor the progress of contaminant reduction in the RGA groundwater following soil mixing.

Comments: Sampling frequencies and parameters were not modified for this sampling program for FY 2020.

Table C.13 provides a listing of MWs, and Table C.14 provides the analytical parameters. Locations are shown on Figure C.7.

Table C.13. SWMU 1 Wells

Semiannual Wells (7)						
MW161	MW542	MW543	MW544	MW545	MW546	MW547

Table C.14. SWMU 1 Analytical Parameters

Volatiles—Method 8260B			
1,1-Dichloroethene	*trans*-1,2-Dichloroethene	Vinyl Chloride	
cis-1,2-Dichloroethene	Trichloroethene		
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

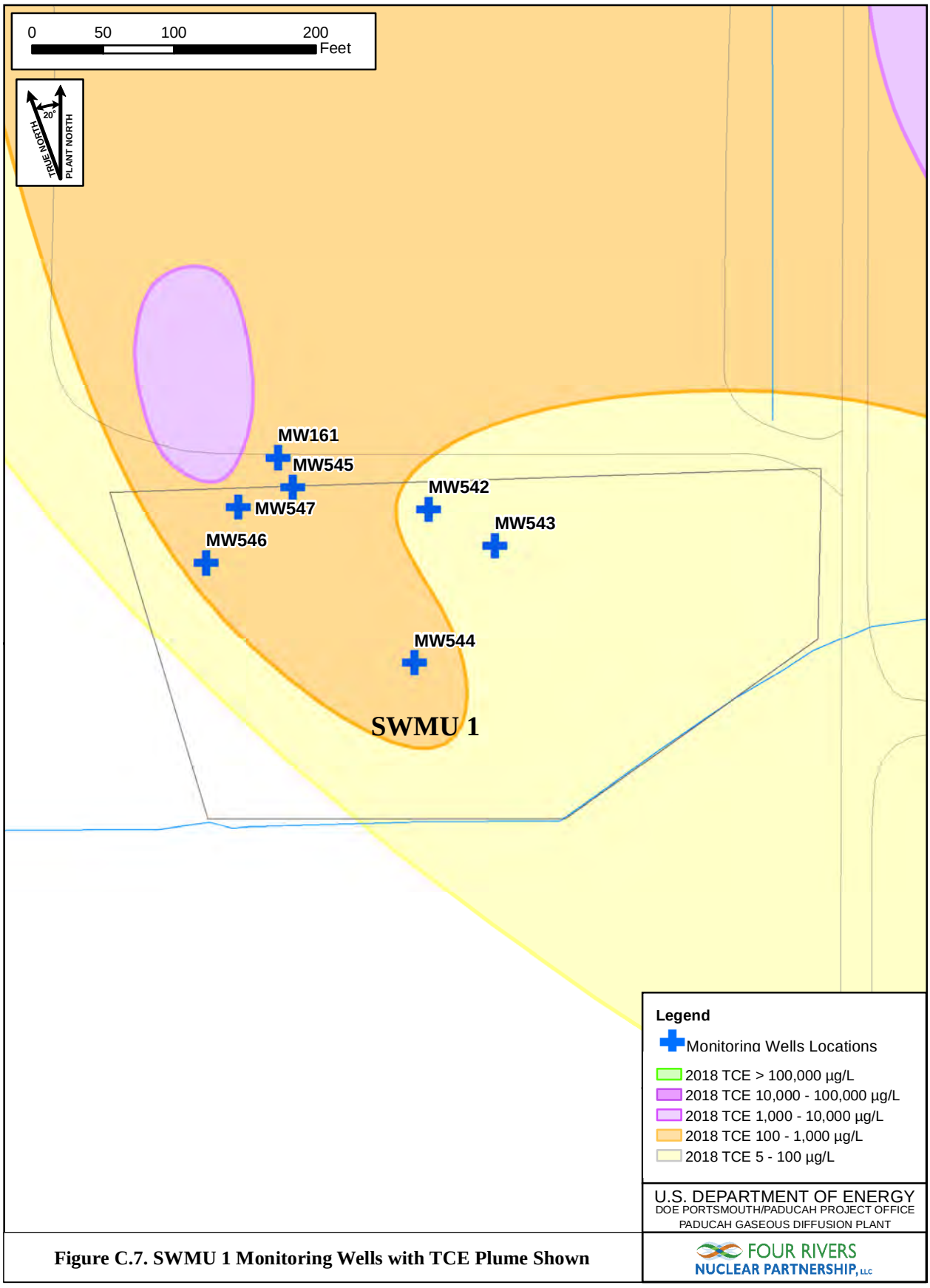

Figure C.7. SWMU 1 Monitoring Wells with TCE Plume Shown

C.2.6 WATER POLICY BOUNDARY MONITORING PROGRAM

Frequency: Quarterly and Annually

Driver: The *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, June 1994 stipulated the need to ensure that residential landowners were provided with water whose well water is contaminated by Paducah Gaseous Diffusion Plant (PGDP) sources. The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the Sampling and Analysis Plan Addendum, which previously was superseded by the EMP.

Reported: Residential well data will be reported to the landowner and may be reported in the ASER. MW data for those MWs located on private property also will be reported to the landowner. Monitoring wells, regardless if located on private property or on DOE property, will be reported in the ASER.

Rationale: A group of residential wells and MWs were chosen to confirm plume migration paths of the Northwest and Northeast Plumes, near the boundaries of the Water Policy Box. Because of the predominant northern flow of groundwater from the site, the concentration of selected wells is more toward the west and east of the site, as opposed to south (see Tables C.15, C.16, and C.17).

Reviews of the data generated through this program may warrant changes to the Water Policy Box [see Figure C.8 (northwest wells) and Figure C.9 (northeast wells)].

Comments: The Water Policy Boundary Monitoring Program was introduced in FY 2013 under this format. Sampling of the residential wells and MWs stated below were previously a part of other programs contained in prior years' EMPs. In order to better capture the objectives stated above, this program was defined as a unique sampling program.

A Groundwater Strategy investigation is being performed to evaluate the extent of TCE and groundwater flow trends near the east and west boundaries of the Water Policy Box. Manual water level measurements and measurements of data loggers/pressure transducer pairs in specific MWs will be used to measure the potentiometric surface and seasonal changes in the potentiometric surface. Measurements of groundwater flow direction using a colloidal borescope in select wells will provide well-specific groundwater flow data in critical areas. MWs planned for colloidal borescope and pressure transducer deployment are included in Appendix B. Also, technetium-99 (Tc-99) was removed from the list of sampling parameters for all wells under this program in FY 2019, except MW432, based on monitoring results and conceptual site models indicating that Tc-99 is not present at levels of concern in the areas of residential wells.

As part of the Groundwater Strategy investigation and evaluation of the Water Policy Box, residential wells along Bethel Church Road and Ogden Landing Road will be evaluated to determine if they are able to be sampled. For those residential wells that are able to be sampled, samples will be collected quarterly for TCE. These potential residential wells are listed in Table C.15.

In FY 2019, the analytical method for uranium isotopes was changed from alpha spectroscopy to inductively coupled plasma mass spectroscopy in order to obtain a lower detection limit. This change is being reflected in this EMP.

Table C.15. Northwestern Wells

Quarterly (20)						
R2	R26	MW106A	MW194	MW202	MW432	MW441
R13	R53	MW134	MW199	MW426	MW433	MW452
R14	R245	MW146	MW201	MW427	MW435	
Quarterly (10)[a]						
R10	R24	R28	R40	R69		
R22	R25	R39	R54	R512		

[a] These residential wells are along Bethel Church Road and Ogden Landing Road. If these wells are able to be sampled, they will only be sampled for TCE.

Table C.16. Northeastern Wells

Annually (7)			
R9	R21	R90	R302
R20	R83	R114	

Table C.17. Residential Analytical Parameters—Northwest and Northeast Analytical Parameters

Field Parameters		
Barometric Pressure	Dissolved Oxygen	pH
Conductivity	Redox	Temperature
Depth to Water*		
Radionuclides—Method ASTM C 1345-08M unless noted		
Uranium-234	Uranium-235	Uranium-238
Technetium-99[a]—**TC-02-RC M**		
Volatiles—Method 8260B		
Trichloroethene		

*As applicable.
[a] Analytical parameter for MW432 only.

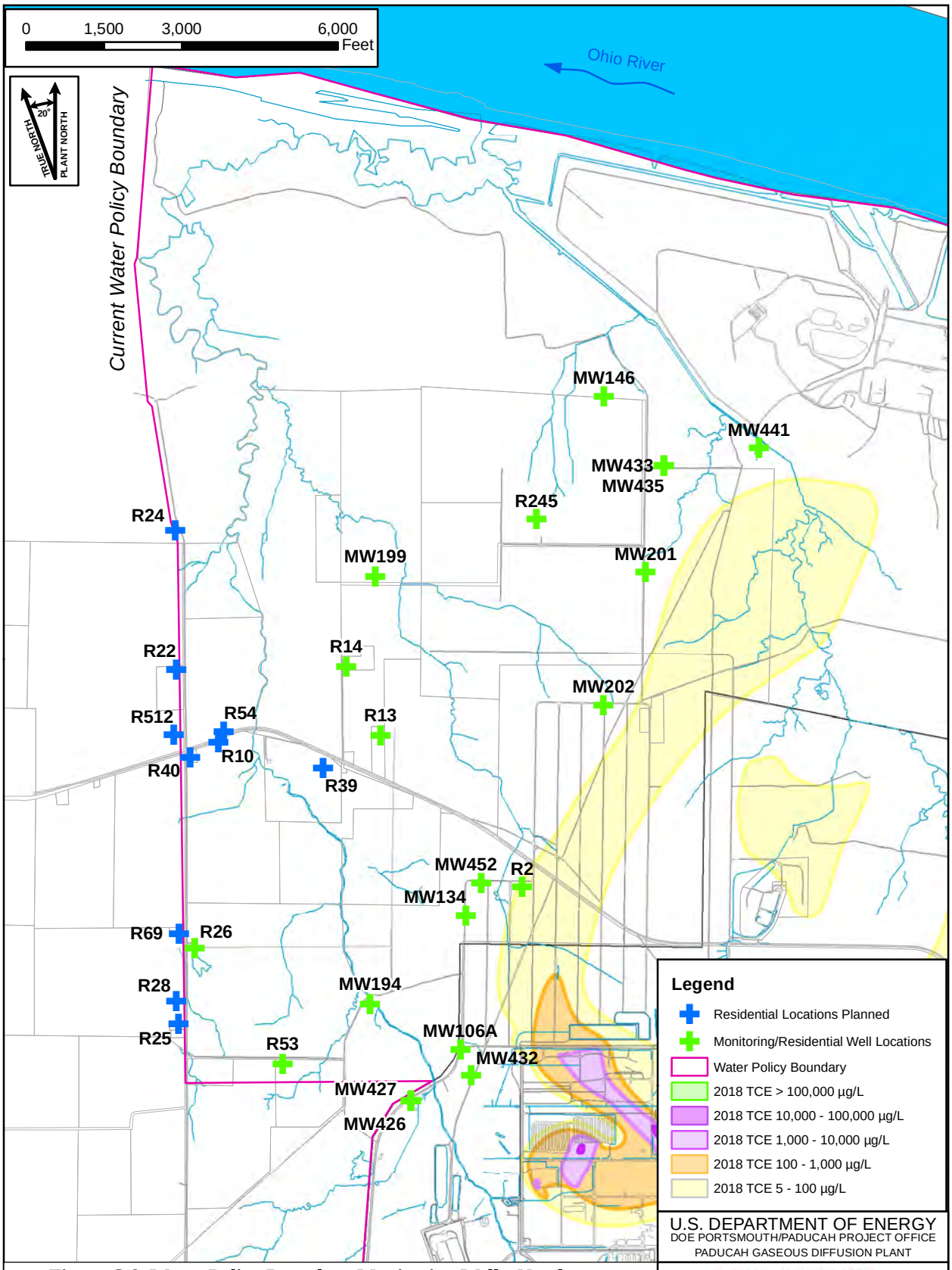

Figure C.8. Water Policy Boundary Monitoring Wells, Northwest with TCE Plume Shown

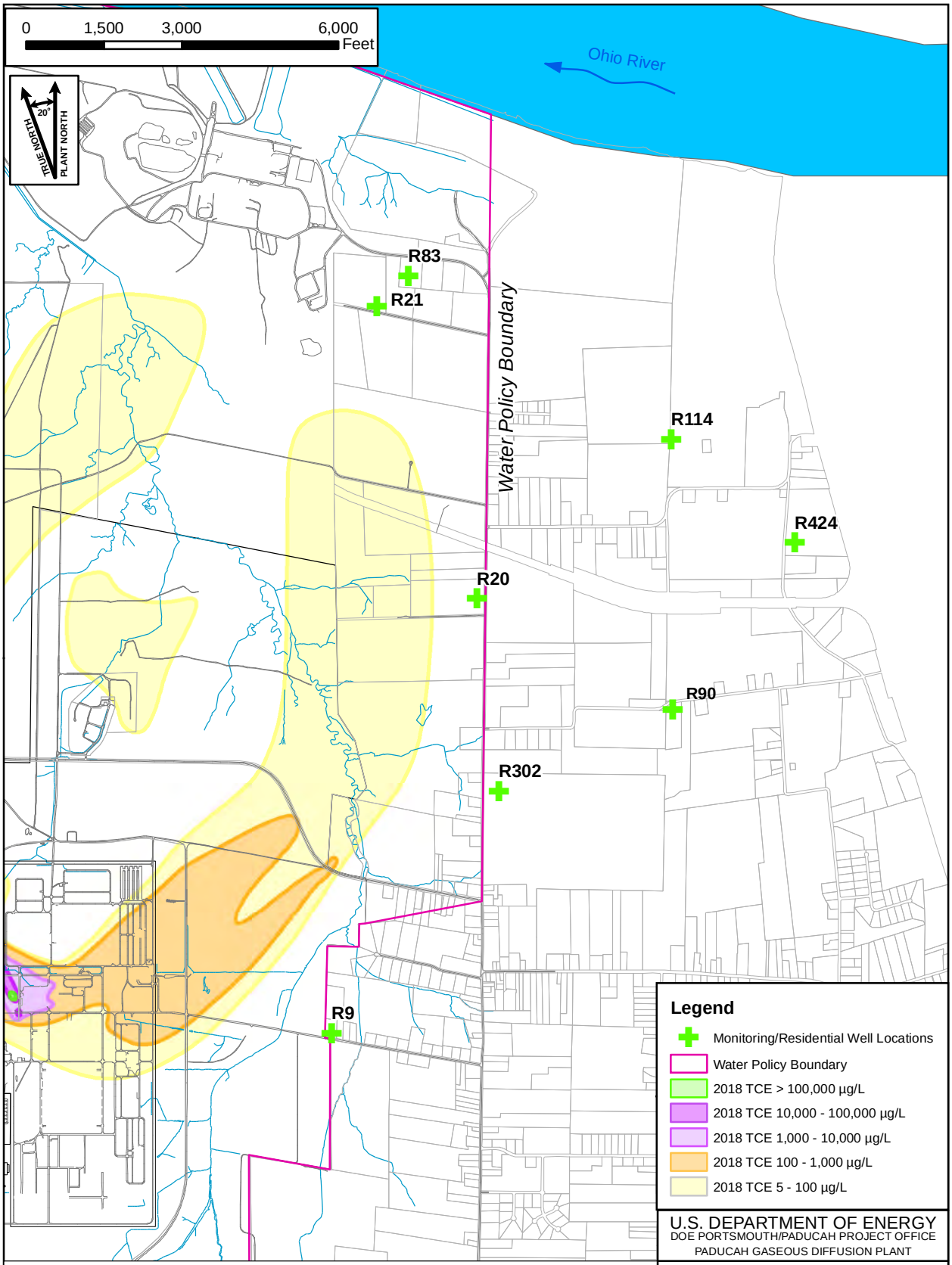

Figure C.9. Water Policy Boundary Monitoring Wells, Northeast with TCE Plume Shown

C.2.7 CARBON FILTER TREATMENT SYSTEM

Frequency: Semiannually (one before treatment sample and one after treatment sample per each semiannual event)

Driver: License agreement with landowner

Reported: Letter to landowner on a semiannual basis and the ASER

Comments: DOE is maintaining a treatment system for one landowner who is outside the Water Policy Box. A license agreement with the landowner stipulates the terms of this arrangement.

Sampling will be conducted for Tc-99 and TCE because they are contaminants of potential concern in groundwater from DOE activities. Based on reviews of the groundwater modeling and historical data, the groundwater at this location is not impacted by site operations. Based on these conditions, Tc-99 sampling frequency was reduced from monthly to semiannual to verify the Tc-99 is below reporting limits. A review of the FY 2019 Tc-99 data did not indicate a need for increased radionuclide analysis; therefore, no changes in sample strategy were made.

Tables C.18 and C.19 identify carbon filter treatment system well and carbon filter treatment system analytical parameters, respectively. Location is shown on Figure C.9.

Table C.18. Carbon Filtration System (1)

R424: Port 1 direct groundwater	R424: Port 3 after ultraviolet light and carbon filter

Table C.19. Carbon Filtration System Analytical Parameters

Field Parameters		
Conductivity	Redox	Temperature
Dissolved Oxygen	pH	
Radionuclides—Method TC-02-RC M		
Technetium-99		
Volatiles—Method 8260B		
Trichloroethene		
Miscellaneous—Method SM 9223		
Total Coliform		

C.2.8 ENVIRONMENTAL SURVEILLANCE GROUNDWATER MONITORING PROGRAM

Environmental Surveillance Monitoring

Frequency: Biennially, Annually, Semiannually, and Quarterly

Driver: DOE Order 436.1 and the Paducah FFA

Reported: ASER

Rationale: Monitoring is conducted to determine the nature and extent of groundwater contamination and groundwater quality. Sampling of these MWs is conducted in support of the Paducah FFA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Investigation; Resource Conservation and Recovery Act Facility Investigations (RFIs); and DOE Order 436.1.

Comments: The program was modified in FY 2011 to focus on sampling key MWs annually and reduce sampling of other MWs to a biennial basis. The biennial grouping of MWs was sampled in FY 2019; therefore, they will not be sampled in FY 2020.

In FY 2019, MW315 and MW330 were sampled for certain per-and polyfluoroalkyl substances at the Fire Training Area (Solid Waste Management Unit 100). Results from this sampling will be available in PEGASIS, reported to EPA and Kentucky Department for Environmental Protection, and reported in the 2019 ASER. Based on these results, additional discussions will be held to determine if additional sampling will be required.

In support of groundwater modeling efforts at the site, McNairy MWs are being added to the semiannual sampling. Most of these MWs have not been sampled in over 10 years. If the MWs are able to produce enough water to be sampled, samples will be collected for volatiles, Tc-99, and uranium as a metal.

MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583 and will be included in the annual group of MWs once it has been installed.

The MWs to be monitored annually were selected based on their location within the plumes. Some MWs are key for early detection of plume migration; others are key for ongoing CERCLA decisions.

Tables C.20 and C.21 identify MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

Table C.20. Surveillance Wells (130)

Biennial (82)					
MW67	MW193[e]	MW404: Port 4	MW447	MW480	MW550[b]
MW76	MW200	MW405: Port 5	MW448	MW481	MW551[b]
MW86	MW201[e]	MW406: Port 5	MW450	MW482	**Background (1)**
MW89	MW202[e]	MW407: Port 4	MW451	MW485[e]	MW103
MW92	MW205	MW408: Port 5	MW452	MW486A[e]	
MW95A	MW226	MW414	MW465[e]	MW487[e]	
MW106A[e]	MW227	MW415	MW466[e]	MW489	
MW146[e]	MW260	MW416	MW467[e]	MW490	
MW148[e]	MW262	MW417	MW468[e]	MW491	
MW149[e]	MW328	MW432	MW473[e]	MW492	
MW163	MW329	MW435[e]	MW474[e]	MW493	
MW168	MW333	MW439[e]	MW475[e]	MW494	
MW169	MW337	MW442	MW476[e]	MW495	
MW174	MW338	MW443	MW477[e]	MW496	
MW186	MW341	MW444	MW478	MW548[b]	
MW187	MW343	MW445	MW479	MW549[b]	
Annual (29)					
MW68[a]	MW161	MW252[e]	MW453	MW471[e]	**Background (1)**
MW71[a]	MW182[c]	MW253A[e]	MW454	MW472[e]	MW150
MW99[e]	MW191[e]	MW261	MW463[e]	MW483[e]	
MW100[e]	MW203	MW345	MW464[e]	MW484[e]	
MW125	MW236	MW418[c]	MW469[e]	MW488	
MW139	MW240	MW419[c]	MW470[e]		
Semiannual (14)					
MW98	MW121[f]	MW135	MW247[f]	MW410[d]	
MW102[f]	MW122[f]	MW197	MW356[f]	MW411[d]	
MW120[f]	MW133[f]	MW239[f]	MW409[d]		
Quarterly (3)					
MW354	MW403: Port 3	MW431[e]			

[a] Sampling will occur at the same time as the second quarter CY sampling event for MW505, MW506, and MW507, which are under the C-400 MW sampling program.
[b] SWMU 4 MWs.
[c] These three wells will be sampled for PCBs in addition to the remaining parameters.
[d] These three wells will be sampled for TCE only to evaluate Northeast Plume migration. These wells previously were included in the Northeast Plume monitoring section as being sampled semiannually for TCE only.
[e] These wells will not be sampled for Tc-99 based on a recommendation in the Technical Memorandum provided to DOE by EarthCon, Consultants, Inc.
[f] If these MWs produce enough water for sampling, samples will be collected for volatiles, Tc-99, and uranium as a metal.
Shading indicates MWs are not scheduled to be sampled this FY.

Table C.21. Environmental Surveillance and Analytical Parameters

Biennial, Annual, Semiannual, and Quarterly			
Field Parameters			
Barometric Pressure	Depth to Water	pH	Temperature
Conductivity	Dissolved Oxygen	Redox	Turbidity
PCBs (MW182, MW418, and MW419)—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	
PCB-1221			
Radionuclides—Method TC-02-RC M			
Technetium-99			
Metals—Method 6020			
Uranium			
Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			

*Xylenes

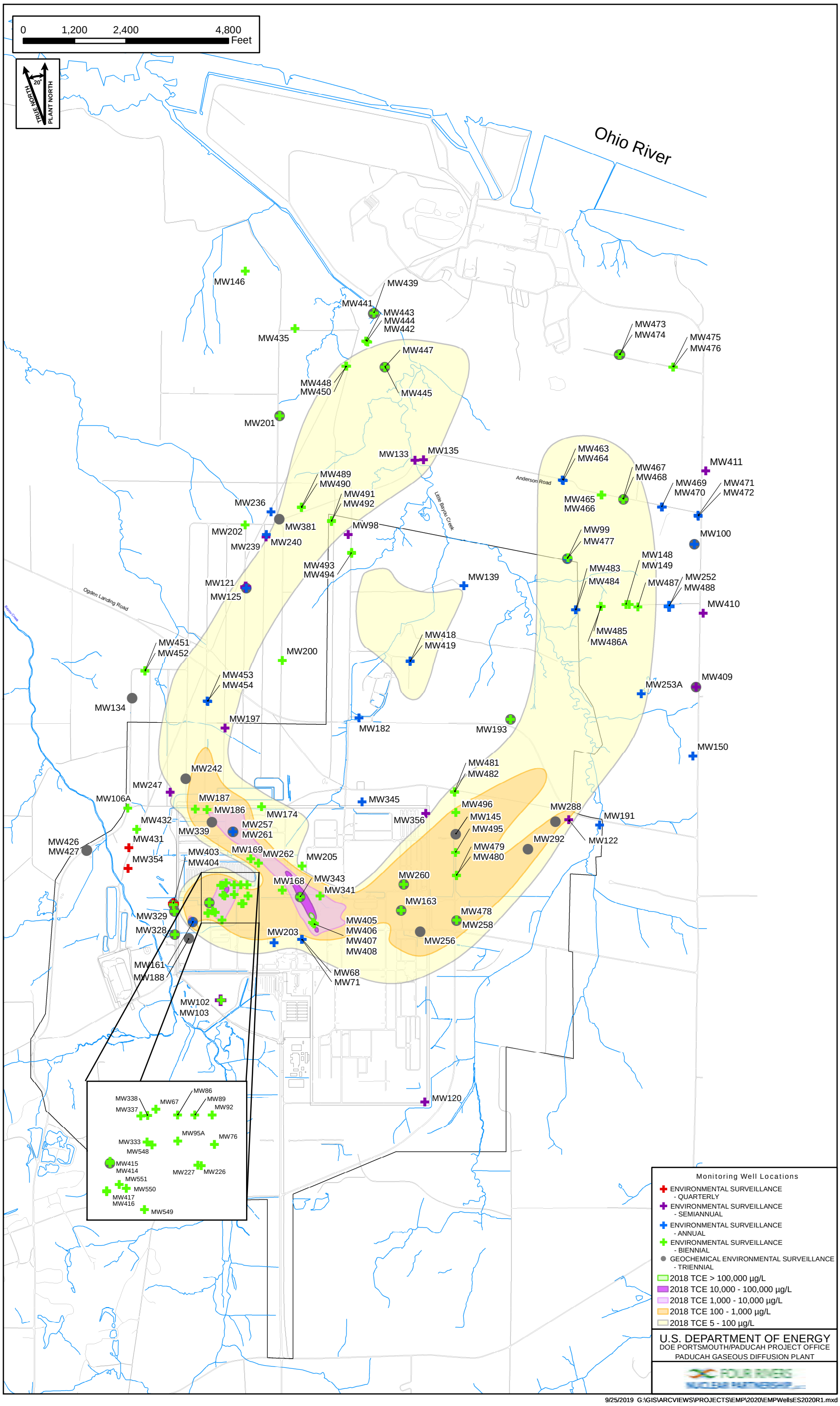

Figure C.10. Environmental Surveillance Groundwater Monitoring Wells with TCE Plume Shown

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Geochemical Environmental Surveillance Monitoring

Frequency: Triennially

Driver: DOE Order 436.1 and the Paducah FFA

Reported: ASER

Rationale: Monitor the extent of groundwater contamination and groundwater quality. Sampling of these MWs is conducted in support of the Paducah FFA CERCLA Investigation, RFIs, and DOE Order 436.1.

Comments: The program was modified in FY 2011 to reduce sampling from an annual basis to a triennial basis. The MWs were sampled in FY 2019; therefore, they will be sampled in FY 2022.

MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583 and will be included in the annual group of MWs once it has been installed.

Tables C.22 and C.23 show MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

Table C.22. Surveillance Geochemical Wells (37)

MW99	MW193	MW288	MW404: Port 3	MW441
MW100	MW201	MW292	MW404: Port 4	MW447
MW125	MW242	MW328	MW404: Port 5	MW468
MW134	MW256	MW329	MW409	MW473
MW145	MW257	MW339	MW414	MW474
MW161	MW258	MW343	MW426	
MW163	MW260	MW381	MW427	
MW188	MW261	MW403: Port 3	MW439	

Shading indicates MWs are not scheduled to be sampled this FY.

Table C.23. Surveillance Geochemical Triennial Analytical Parameters

Anions—Method 9056			
Chloride	Nitrate	Phosphate	Sulfate
Fluoride			
Miscellaneous—As noted			
Alkalinity—310.1	**Silica—200.7**		
Total Dissolved Solids—160.1	**Total Organic Carbon—9060**		
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Ferrous Iron (Fe^{+2})
Volatiles—Procedure RSK 175			
Ethene	Ethane	Methane	
Metals—Method 6020			
Aluminum	Calcium	Magnesium	Silver
Antimony	Chromium	Manganese	Selenium
Arsenic	Cobalt	Molybdenum	Sodium
Barium	Copper	Nickel	Zinc
Beryllium	Iron	Potassium	Uranium
Cadmium	Lead		

Bolded parameters are sampled by different method than specified in header.

C.3. SURFACE WATER, SEDIMENT, AND WATERSHED BIOLOGICAL MONITORING

C.3.1 EFFLUENT WATERSHED MONITORING PROGRAM

C-746-S, C-746-T, and C-746-U Landfills Surface Water

Frequency: Quarterly

Driver: Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045, Technical Attachment 24, which includes the surface water monitoring plans.

Reported: Quarterly C-746-S&T and C-746-U Landfills Compliance Monitoring Reports and the ASER

Rationale: Monitor rain runoff from the C-746-S, C-746-T, and C-746-U Landfills.

Comments: Field measurements for Dissolved Oxygen, Flow Rate, and Temperature have been removed because they are not required by the permit.

Surface water sampling is performed and reported collectively for the C-746-S and C-746-T Landfills.

Tables C.24 and C.25 show landfill surface water locations and landfill surface water parameters, respectively. Locations are shown on Figure C.11.

Table C.24. Landfill Surface Water Locations (6)

C-746-S&T		
L135	L136	L154*
C-746-U		
L150	L154*	L351

*L154 is reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills.

Table C.25. Landfill Surface Water Parameters

Anions—Method 300.0		
Chloride	Sulfate	
Field Measurements		
Conductivity		
pH		
Metals—Method 200.8		
Iron	Sodium	Uranium
Miscellaneous—Methods as follows		
Total Dissolved Solids—160.1	**Total Solids—SM 2540B**	**Total Organic Carbon—9060**
Total Suspended Solids—160.2	**Chemical Oxygen Demand—410.4**	
Radionuclides—Method 9310		
Alpha Activity	Beta Activity	

Bolded parameters are sampled by different method than specified in header.

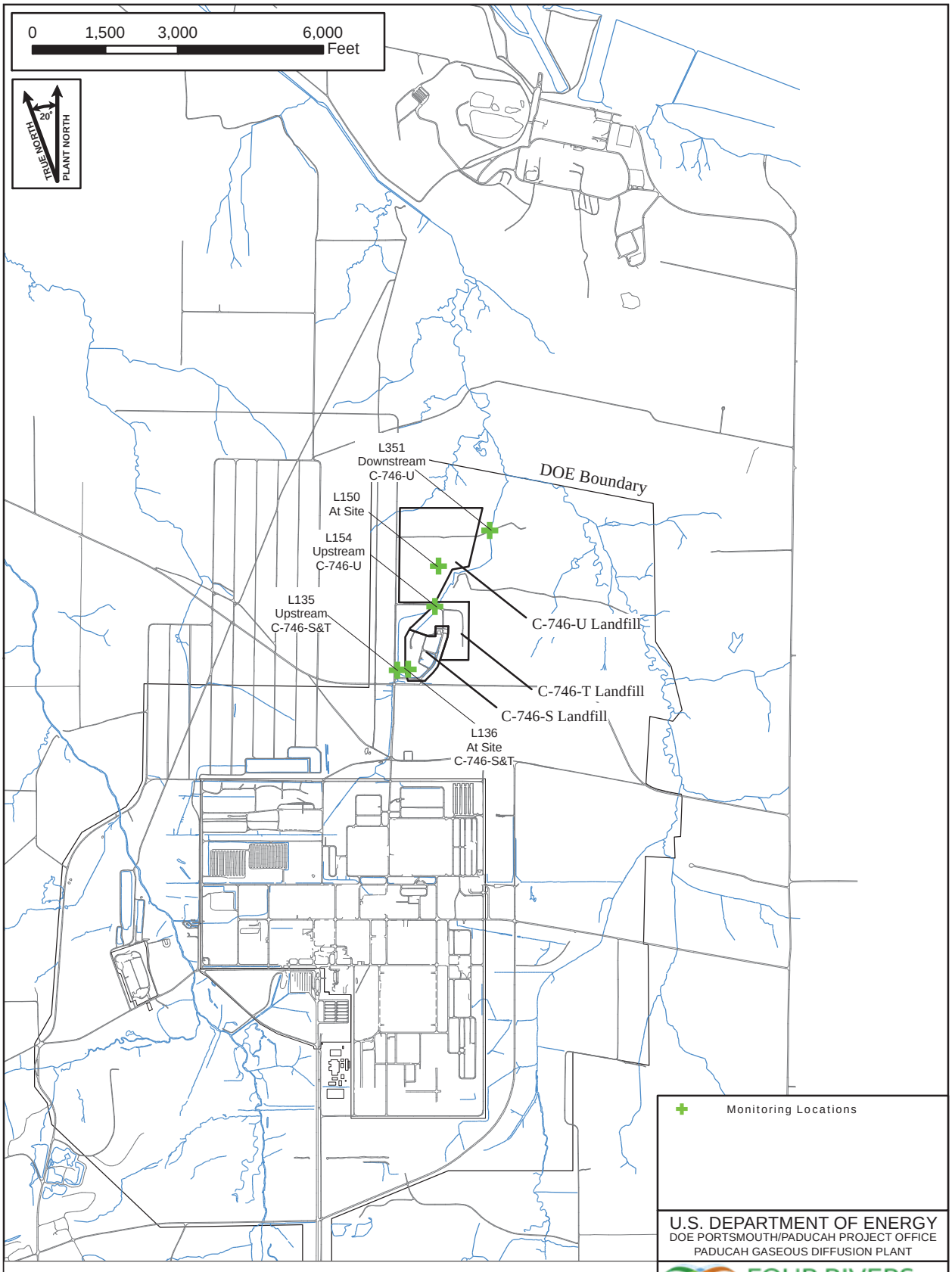

Figure C.11. Landfill Surface Water Locations

Kentucky Pollutant Discharge Elimination System Outfall Sampling

Frequency: Weekly, Monthly, and Quarterly

Driver: Kentucky Pollutant Discharge Elimination System (KPDES) permit for PGDP, permit number KY0004049, was issued by the Kentucky Division of Water to DOE, Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP), and Mid-America Conversion Services, LLC, and became effective September 1, 2017. A permit modification dated October 12, 2017, changed the co-permittee from FPDP to FRNP.

Reported: Monthly and Quarterly Discharge Monitoring Reports; weekly sampling is reported in the monthly reports and ASER

Rationale: Monitor effluent and surface water runoff as it is discharged to the receiving streams and tributaries.

Comments: Table C.26 shows the KPDES outfall sampling locations, frequency of sampling, and parameters required by permit KY0004049. Locations are shown on Figure C.12.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2020 because it is permit driven.

CERCLA Outfall Sampling

Frequency: Weekly and Quarterly

Driver: Sampling of this outfall is required by the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1535&D3/R6, September 2017, and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1280&D2/R3/A1, July 2018.

Reported: Semiannual FFA Progress Report and ASER

Rationale: Monitor effluent from the Northeast Plume containment system.

Comments: Table C.27 shows the frequency of sampling and parameters required for this CERCLA outfall (C001).

Table C.26. KY0004049 Permit
KPDES Outfall Sampling Locations, Frequency, and Parameters

Analysis-Method	Frequency of Sampling at KPDES Locations W—Weekly; M—Monthly; Q—Quarterly														
	K001	**K002**	**K004**	**K006**	**K008**	**K009**	**K010**	**K011**	**K012**	**K013**	**K015**	**K016**	**K017**	**K019**	**K020**
Flow (Mgd)—Field	D	M	2/M	M	M	M	M	M	M	M	M	M	M	M	M
Total Suspended Solids (mg/L)—SM 2540 D	W	M	2/M	M	M	M	M	M	M	M	M	M	M	M	M
Oil & Grease (mg/L)—1664A	W	M		M	M	M	M	M	M	M	M	M	M	M	M
Total Residual Chlorine (µg/L)—Field	W			M	M										
Temperature (°F)—Field	W				M										
PCBs (µg/L)—608.3	W	M			M	M	M	M	M	M	M	M	M	M	M
Trichloroethene (µg/L)—624.1	W	M			M	M	M	M	M	M	M	M	M	M	M
Total Phosphorus (mg/L)—365.4	W				M										
Alpha Activity (pCi/L)—9310	W	M			M	M	M	M	M	M	M	M	M	M	M
Beta Activity (pCi/L)—9310	W	M			M	M	M	M	M	M	M	M	M	M	M
Uranium (µg/L)—-200.8	W	M			M	M	M	M	M	M	M	M	M	M	M
Acute Toxicity (TU_A)[a]—2000.0/2002.0													Q		

Table C.26. KY0004049 Permit
KPDES Outfall Sampling Locations, Frequency, and Parameters (Continued)

Analysis-Method	Frequency of Sampling at KPDES Locations W—Weekly; M—Monthly; Q—Quarterly														
	K001	**K002**	**K004**	**K006**	**K008**	**K009**	**K010**	**K011**	**K012**	**K013**	**K015**	**K016**	**K017**	**K019**	**K020**
Chronic Toxicity (TU_c)[b]—1000.0/1002.0	Q						Q	[c]							
Total Recoverable Copper (µg/L)—200.8		M													
Total Recoverable Zinc (µg/L)—200.8										M			M		
Technetium-99 (pCi/L)—TC-02-RC M	Q	M			M	M	M	M	M	M	M	M	M	M	M
Hardness (as mg/L $CaCO_3$)—SM 2340 C		M								M			M		
BOD_5 (mg/L)—SM 5210 B			2/M												
pH—Field	W	M		M	M	M	M	M	M	M	M	M	M	M	M

[a] Acute toxicity sampling requires two discrete grab samples collected approximately 12 hours apart. A different lab method is used for each species.
[b] Chronic toxicity sampling requires three 24-hour composite samples. Monitoring for K010 is not required when the effluent from the C-617 Lagoon is discharged through K011. A different lab method is used for each species.
[c] Monitoring for K011 is required only when the effluent from the C-617 Lagoon is discharged through the outfall.

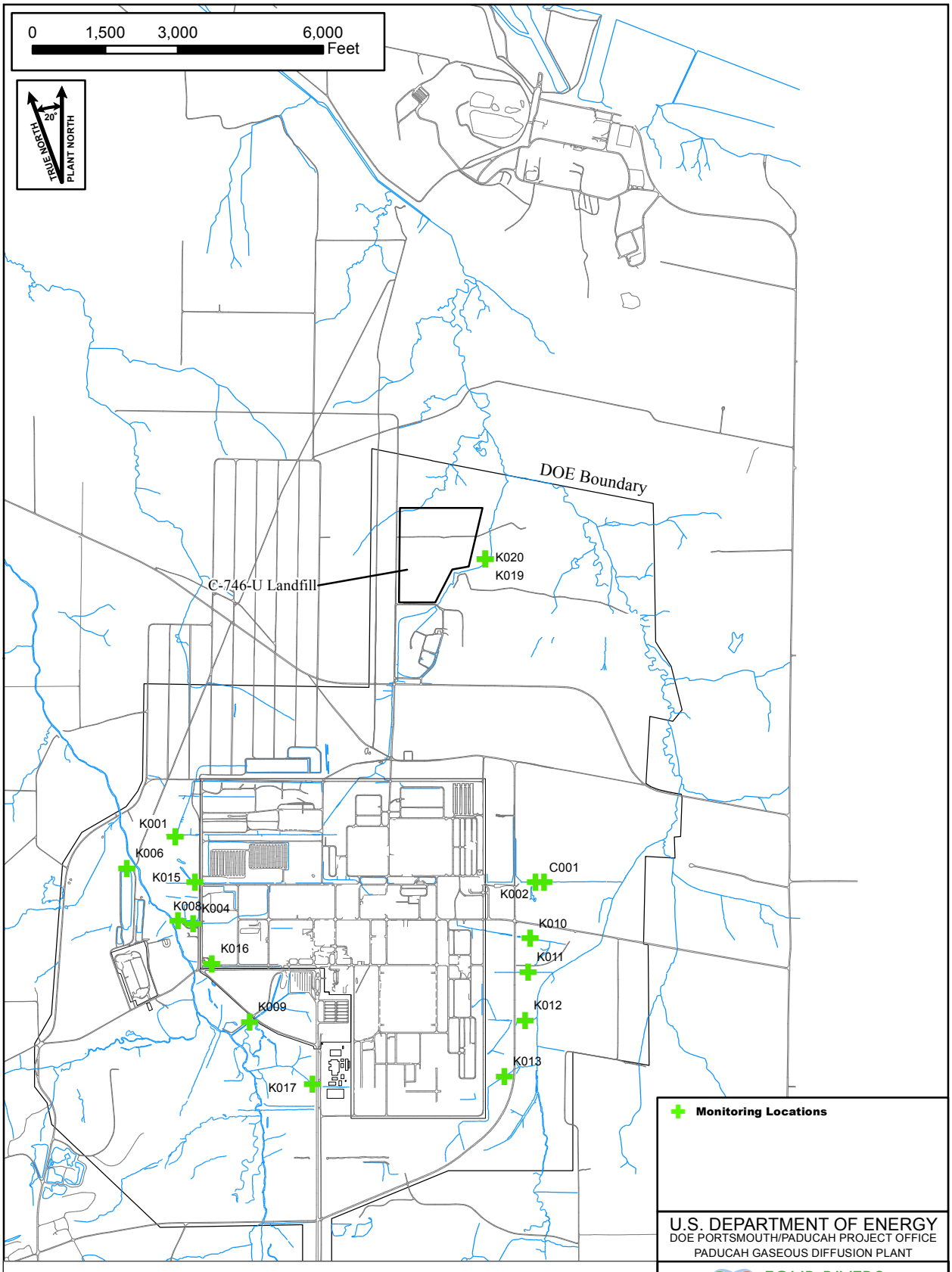

Figure C.12. KPDES and CERCLA Outfall Sampling Locations

Table C.27. C001 Outfall Sampling Frequency and Parameters

Analysis-Method	Frequency of Sampling at C001 Outfall W—Weekly; Q—Quarterly
	C001
Flow (Mgd)—Field	W
Total Suspended Solids (mg/L)—160.2	W
Oil & Grease (mg/L)—1664A	W
Total Residual Chlorine (mg/L)—Field	W
Temperature (°F)—Field	W
Trichloroethene (mg/L)—624.1	W
1,1-Dichloroethene (mg/L)—624.1	W
Chronic Toxicity (TU_c)[a] —1000.0/1002.0	Q
Technetium-99 (pCi/L)—TC-02-RC M[b]	Q
pH—Field	W

[a] Chronic toxicity sampling requires three 24-hour composite samples. A different lab procedure is used for each species.
[b] Technetium-99 is required under the Remedial Action Work Plan for the Northeast Plume.

C.3.2 ENVIRONMENTAL RADIATION PROTECTION PROGRAM—EFFLUENT AND SURFACE WATER RUNOFF

Frequency: Monthly

Driver: DOE Order 458.1 and DOE-STD-1196-2011, Derived Concentration Technical Standard

Reported: ASER

Rationale: Monitor effluent and surface water runoff for radiological constituents as it is discharged to the receiving streams and tributaries.

Comments: DOE Order 458.1 was implemented during FY 2013 with the effective date being January 2, 2013. DOE Order 458.1 requires compliance in accordance with DOE-STD-1196-2011, *Derived Concentration Technical Standard*. DOE Order 458.1 also requires that settleable solids on liquid discharges do not exceed limits set forth in DOE Order 458.1, Attachment 1 2.g.(4). Total suspended solids is (TSS) analyzed for the ERPP outfall locations, with the exception of Outfall 020. If TSS is greater than 40 mg/L, the laboratory will be asked to analyze the filtered material for alpha activity and beta activity. These results will be compared to the sediment background data to evaluate if the radionuclide concentration exceeds the standard.

The threshold limits for alpha activity and beta activity are being removed and full isotopic analysis is being performed on all samples in order to evaluate low-level concentrations of radionuclides. This change is not due to any increasing trend, but to help in determining dose concentrations to the maximally exposed individual.

Table C.28 lists the sampling locations, frequencies, and parameters. Locations are shown on Figure C.13.

Table C.28. ERPP Effluent and Surface Water Runoff

Analysis—Method	Analytical Parameters M—Monthly													
	K001 ERPP	K002 ERPP	K004 ERPP	K008 ERPP	K009 ERPP	K010 ERPP	K011 ERPP	K012 ERPP	K013 ERPP	K015 ERPP	K016 ERPP	K017 ERPP	K019 ERPP	K020 ERPP
Alpha activity (pCi/L)—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Beta activity (pCi/L)—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Americium-241 (pCi/L)—AM-05-RC	M		M	M	M	M	M	M		M	M			
Cesium-137 (pCi/L)—901.1			M	M						M	M			
Neptunium-237 (pCi/L)—1475-00aM	M		M	M	M	M	M	M		M	M			
Plutonium-238 (pCi/L)—PU-11-RC M	M		M	M	M	M	M	M		M	M			
Plutonium-239/240 (pCi/L)—PU-11-RC M	M		M	M	M	M	M	M		M	M			
Technetium-99 (pCi/L)—TC-02-RC M	M		M											
Thorium-230 (pCi/L)—Th-01-RC M	M		M	M	M	M	M	M		M	M			
*Alpha activity on the filtered material [Settleable Solids (pCi/g)]—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	
*Beta activity on the filtered material [Settleable Solids (pCi/g)]—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	
Uranium-234 (pCi/L)—U-02-RC M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Uranium-235 (pCi/L)—U-02-RC M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Uranium-238 (pCi/L)—U-02-RC M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

NOTE: Samples are being collected from locations near the outfalls listed in KPDES permit KY0004049.

*In order to obtain sufficient data to make a determination of dose from settleable solids, TSS, dissolved alpha, dissolved beta, suspended alpha, and suspended beta results will be provided by the laboratory. If TSS is greater than 40 mg/L, the laboratory will be asked to analyze the filtered material for alpha activity and beta activity.

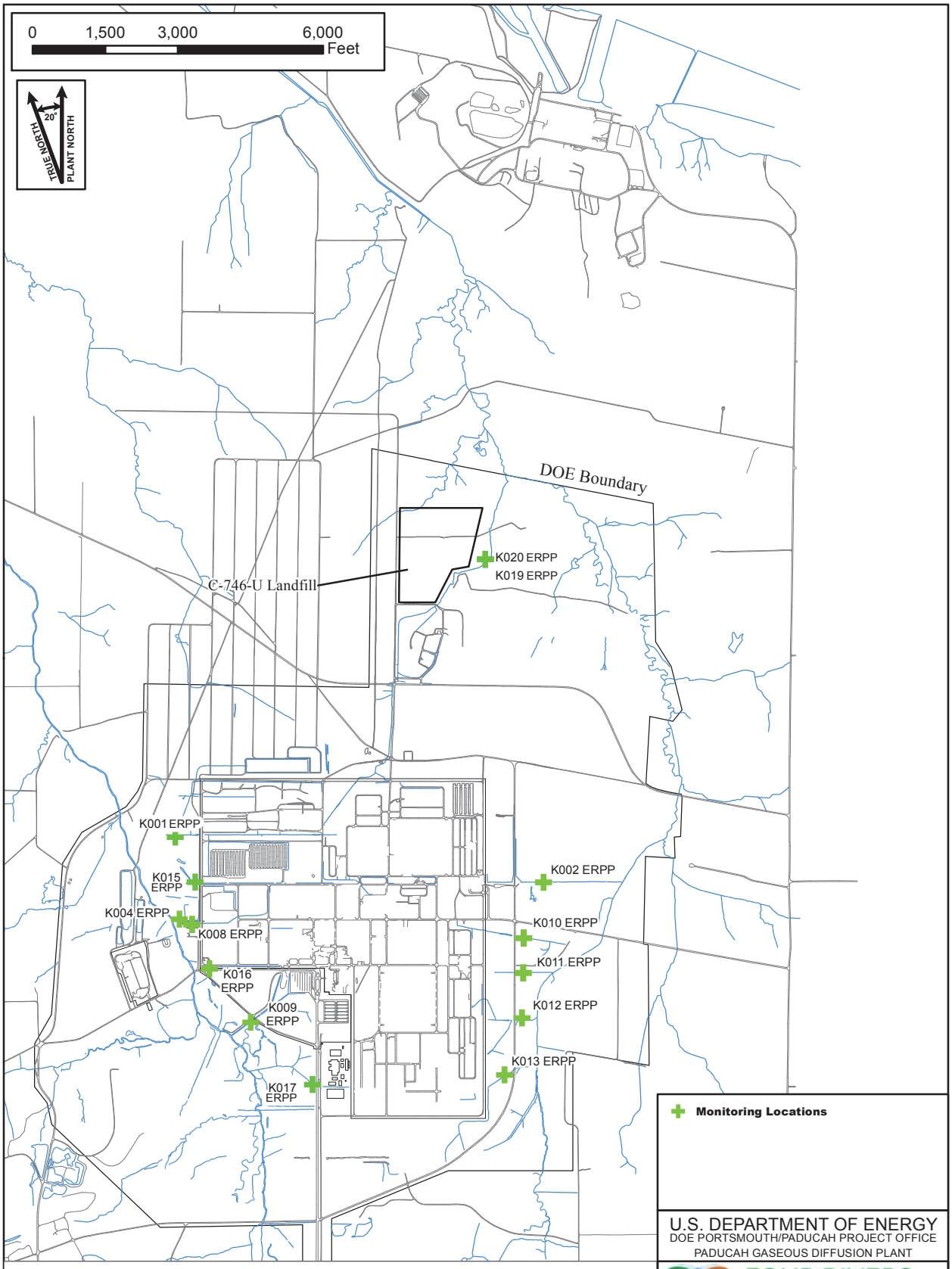

Figure C.13. Surface Water Monitoring near KPDES Outfalls

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8/18/2016

C.3.3 C-613 NORTHWEST STORM WATER CONTROL FACILITY

C-613 Sediment Basin—Storm Water

Frequency: Quarterly

Driver: Quarterly sampling is required by the *Operation and Maintenance Plan for the Northwest Storm Water Control Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2044&D1/R4, September 2009.

Reported: Reported to KDWM via electronic mail.

Rationale: Prior to a discharge event, the pH and TSS is measured to prevent a discharge that would cause the effluent monitored at KPDES Outfall 001 to exceed regulatory limits. Operational monitoring is not covered under the EM Program but is managed by the operations manager or designee. As specified in the Operations and Maintenance Plan, a sample is to be collected each quarter to confirm the pH and TSS field measurements.

Comments: Table C.29 provides a listing of the analytical parameters. Location of the C-613 Sediment Basin is shown on Figure C.14.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2020.

Table C.29. C-613 Sediment Basin Quarterly Water Parameters

Miscellaneous—Method 160.2	
Total Suspended Solids	
Field Parameters	
pH	Turbidity

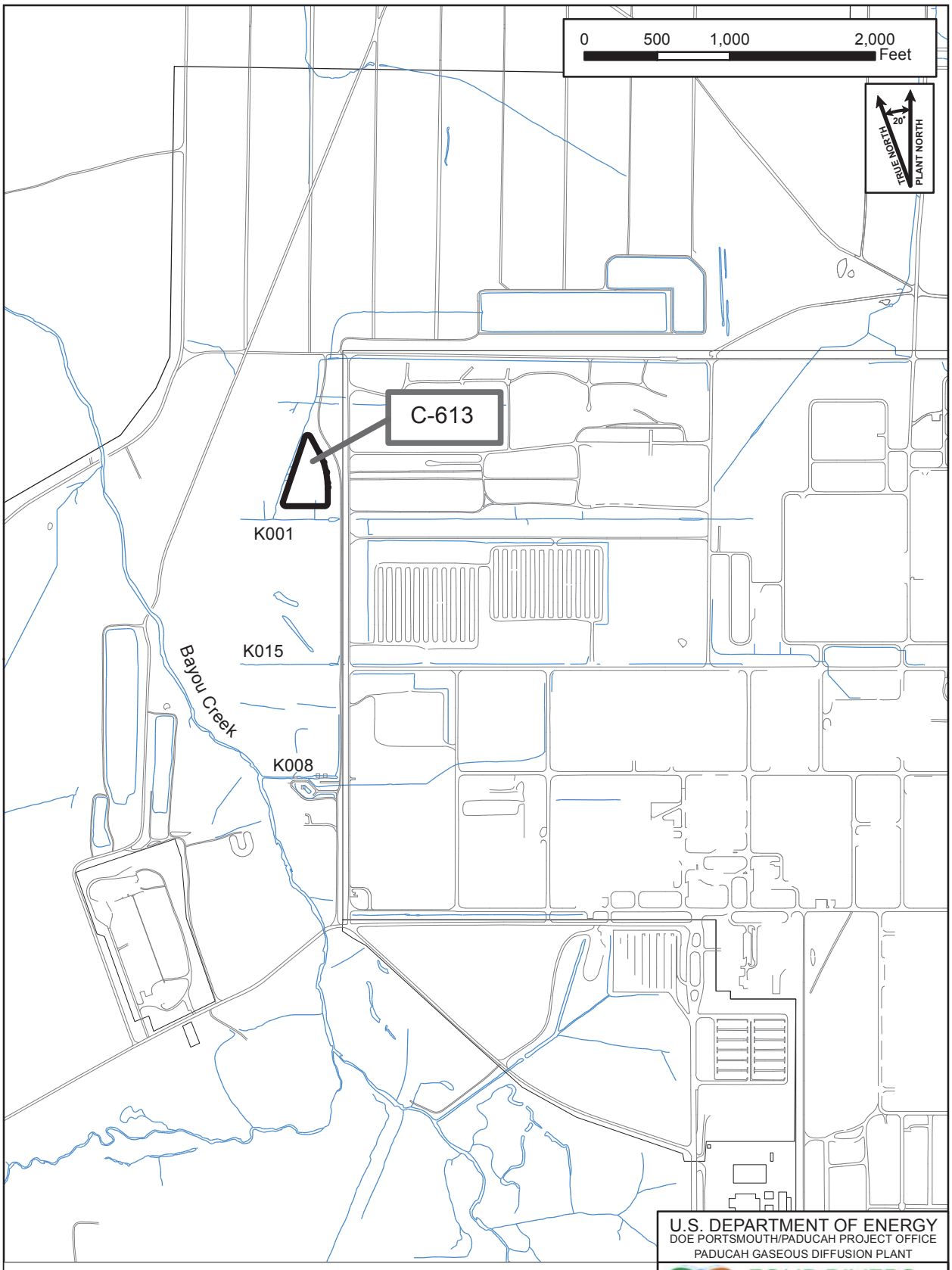

Figure C.14. C-613 Sediment Basin

C.3.4 ENVIRONMENTAL SURVEILLANCE WATERSHED MONITORING PROGRAM

Surface Water Monitoring

Frequency: Quarterly and Annually

Driver: *Record of Decision for Waste Area Groups 1 and 7 for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D2, September 1997, requires monitoring of surface water locations near the C-746-K Landfill. DOE Order 458.1 requires radiological monitoring.

Reported: ASER

Rationale: To monitor potential contamination released into Bayou Creek and Little Bayou Creek surface water from plant operations.

Comments: DOE Order 458.1 requires that environmental surveillance be performed in accordance with DOE/HDBK-1216-2015. Sampling locations were selected to determine site-specific radiation exposure pathway analysis. Locations were prioritized for areas of public access, introduction of plant effluents to the environment and verification of the effectiveness of PGDP effluent monitoring.

The threshold limits for alpha activity and beta activity are being removed and full isotopic analysis is being performed on all samples in order to evaluate low-level concentrations of radionuclides. This change is not due to any increasing trend, but to help in determining dose concentrations to the maximally exposed individual. Background location L1 was chosen to support data comparisons of data generated as part of this program, as well as the ERPP Effluent and Surface Water Runoff program outlined in Section C.3.2.

The previous KPDES permit required that 19 in-stream surface water locations be sampled quarterly for PCBs and TCE. The new KPDES permit, permit number KY0004049, does not require this sampling; therefore this sampling program was modified in FY 2018 to include only locations near C-746-K Landfill (C746K-5 and K746KTB1A) and a seep location (LBCSP5) in Little Bayou Creek. The sampling of surface water near the C-746-K Landfill meets the requirements of the ROD listed above and will be analyzed for volatiles and metals. The seep location will be monitored for TCE and is being sampled for continued evaluation of trends in groundwater upwelling at this location. The surface water monitoring program will be evaluated for FY 2021 to determine if any changes are needed. L14 was added to the quarterly ERPP sampling program in FY 2018 to include monitoring upstream of the C-746-S&T and C-746-U Landfills. During sampling in FY 2018, it was determined that the sample should be collected downstream of L14 in order to obtain enough flow to collect a sample. The location is L14DWN.

Table C.30 details surface water and the seep sampling locations. Tables C.31 and C.32 detail the surface water and seep sampling analytical parameters. Tables C.33 through C.36 detail the surface water and seep sampling analytical parameters by location for the ERPP. Sampling to support the ERPP will be conducted on a quarterly basis, with the exception of the background locations (L1 and L30), which will be sampled annually. Locations are shown on Figure C.15.

Table C.30. Surface Water and Seep Quarterly Sampling Locations (3)

Surface Water (2)	
C-746-K-5	**Seep (1)**
C746KTB1A	LBCSP5*

*Unable to obtain flow rates.

Table C.31. Surface Water Quarterly Analytical Parameters

Metals—Method 200.8		
Aluminum	Calcium	Nickel
Arsenic	Iron	Potassium
Barium	Lead	Sodium
Beryllium	Magnesium	Uranium
Cadmium	Manganese	
Field Measurements		
Alkalinity	Dissolved Oxygen	pH
Conductivity	Flow*	Temperature
Volatiles—Method 624.1		
1,1-Dichloroethene	*cis*-1,2-Dichloroethene	*trans*-1,2-Dichloroethene
Trichloroethene	Vinyl Chloride	

*See Table C.30 for locations where flow rates are not collected.

Table C.32. Seep Location Quarterly Analytical Parameters

Volatiles—Method 624.1	
Trichloroethene	
Field Measurements	
pH	Dissolved Oxygen
Temperature	Conductivity

Table C.33. Surface Water—ERPP Little Bayou Creek Locations and Quarterly Analytical Parameters (3)

Locations		
L10	L14DWN	L241
Radionuclides—Method U-02-RC M unless noted		
Alpha Activity—9310		Uranium-234
Beta Activity—9310		Uranium-235
Technetium-99—TC-02-RC M		Uranium-238
Uranium		

Bolded parameters are sampled by different method than specified in header.

Table C.34. Surface Water—ERPP Bayou Creek Location and Quarterly Analytical Parameters (1)

Location	
L5	
Radionuclides—Method U-02-RC M unless noted	
Alpha Activity—9310	**Cesium-137—901.1**
Beta Activity—9310	**Technetium-99—TC-02-RC M**
Neptunium-237—1475-00aM	Uranium
Plutonium-238—PU-11-RC M	Uranium-234
Plutonium-239/240—PU-11-RC M	Uranium-235
Thorium-234—901.1	Uranium-238
Potassium-40—901.1	

Bolded parameters are sampled by different method than specified in header.

Table C.35. Surface Water—ERPP North-South Diversion Ditch Location and Quarterly Analytical Parameters (1)

Locations	
L11	
Radionuclides—Method U-02-RC M unless noted	
Alpha Activity—9310	Uranium
Beta Activity—9310	Uranium-234
Thorium-230—Th-01-RC M	Uranium-235
Technetium-99—TC-02-RC M	Uranium-238

Bolded parameters are sampled by different method than specified in header.

Table C.36. Surface Water—ERPP Background and Nearest Public Water Source Location and Quarterly/Annual Analytical Parameters (4)

Locations	
Annually L1 (BG) and L30 (BG to PWS) Quarterly L29A (BG) and L306 (PWS at Cairo, Illinois)	
Radionuclides—Method U-02-RC M unless noted	
Alpha Activity—9310	**Cesium-137—901.1**
Beta Activity—9310	**Technetium-99—TC-02-RC M**
Americium-241—AM-05-RC M	Uranium
Neptunium-237—1475-00aM	Uranium-234
Plutonium-238—PU-11-RC M	Uranium-235
Plutonium-239/240—PU-11-RC M	Uranium-238
Thorium-230—Th-01-RC M	**Alpha activity on the filtered material** [settleable solids (pCi/g)]—9310 **Beta activity on the filtered material** [settleable solids (pCi/g)]—9310

BG = Background locations
PWS = Public Water Source locations
Bolded parameters are sampled by different method than specified in header.

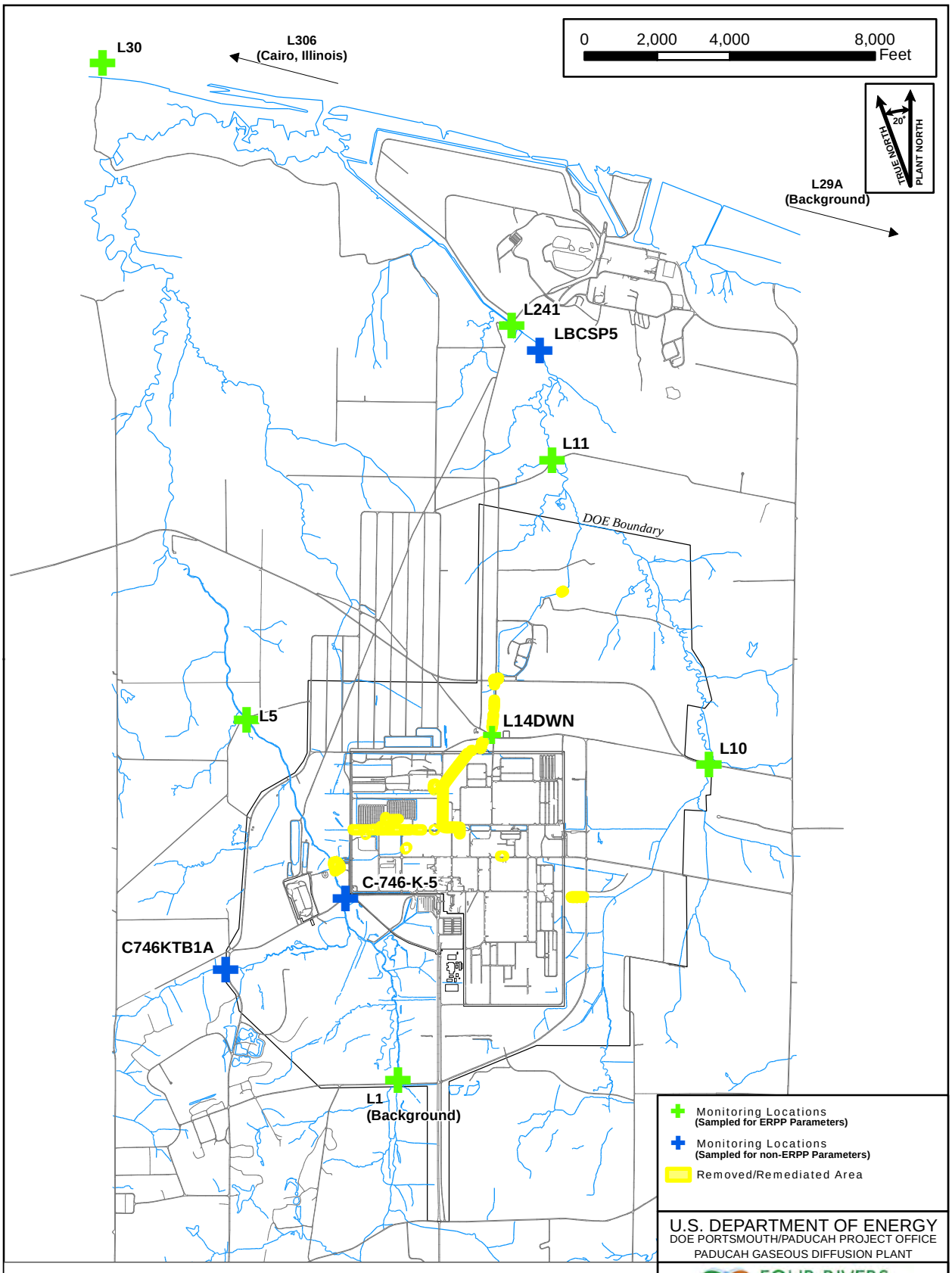

Figure C.15. Surface Water and Seep Monitoring Locations

Sediment Monitoring

Frequency: Semiannually (PCBs) and Annually (Radionuclides)

Driver: Acquisition of PCB data for future "Impaired Waters of Kentucky" discussions. DOE Order 458.1 requires radiological monitoring. This radiological monitoring will be conducted on an annual basis.

Reported: ASER

Rationale: Monitor potential contamination released into Bayou Creek and Little Bayou Creek sediments from historical plant operations.

Comments: DOE Order 458.1 requires that environmental surveillance of sediment be performed in accordance with DOE/HDBK-1216-2015. Sampling locations were selected to determine site-specific radiation exposure pathway analysis and to provide an indication of the accumulation of undissolved radionuclides in the aquatic environment. Locations were prioritized for areas of public access, introduction of plant effluents to the environment, and verification of the effectiveness of the Paducah Site effluent monitoring. Sampling for radionuclides will occur annually.

Table C.37 details sediment sampling locations and parameters. Table C.38 details the sediment sampling locations and parameters driven by the ERPP. The previous KPDES permit required that 14 locations be sampled semiannually for PCBs. The new KPDES permit, permit number KY0004049, no longer requires this sampling; however, these locations will continue to be sampled semiannually for PCBs in FY 2020 in order to evaluate action levels for PCBs in sediment. Locations are shown on Figure C.16.

Table C.37. Sediment—Location and Semiannual Analytical Parameters Sampling Locations (14)

Locations		
C612	S1	S31
C616	S2	S32
746KTB2	S20 (BG)	S33
K001	S27	S34
L194	S28 (BG)	
PCBs—Method 8082		
PCB, Total	PCB-1232	PCB-1254
PCB-1016	PCB-1242	PCB-1260
PCB-1221	PCB-1248	

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

Table C.38. Sediment—ERPP Location and Annual Analytical Parameters Sampling Locations (6)

Locations		
S1	S20 (BG)	S33
S2	S27	S34
Radionuclides—Method U-02-RC M unless noted		
Alpha Activity—9310	**Plutonium-238—PU-11-RC M**	**Technetium-99—TC-02-RC M**
Beta Activity—9310	**Plutonium-239/240—PU-11-RC M**	Uranium
Americium-241—AM-05-RC M	**Thorium-230—Th-01-RC M**	Uranium-234
Neptunium-237—1475-00aM	**Cesium-137—HASL 300 4.5.2.3**	Uranium-235
		Uranium-238

Bolded parameters are sampled by different method than specified in header.
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

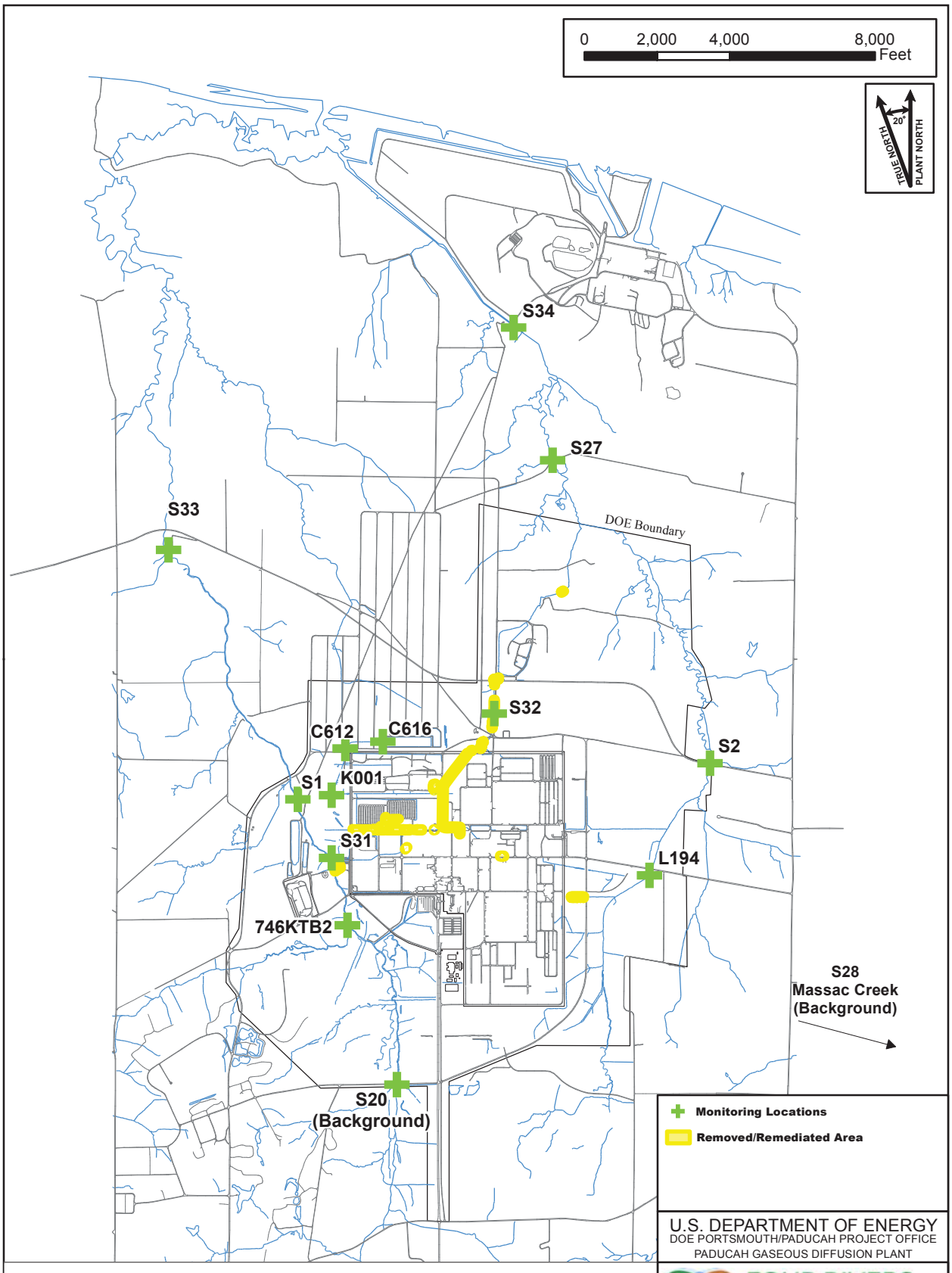

Figure C.16. Semiannual Sediment Locations

C.4. LANDFILL LEACHATE SAMPLING

C-746-S and C-746-U Landfills Leachate Monitoring

Frequency: Annually

Driver: Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045, issued by KDWM.

Reported: Quarterly Compliance Operating Reports, as required by the applicable solid waste landfill permit and the ASER

Rationale: Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045.

Comments: Leachate sampling is performed and reported collectively for the C-746-S Landfill.

Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2020 because it is permit driven.

Annual leachate parameters for C-746-S and C-746-U Landfills are presented in Table C.39.

Table C.39. C-746-S and C-746-U Landfills Annual Leachate Parameters

Volatiles—Method 624.1 unless noted			
1,1,1,2-Tetrachloroethane	1,4-Dichlorobenzene	Carbon Disulfide	Iodomethane
1,1,1-Trichloroethane	2-Butanone	Carbon Tetrachloride	Methylene Chloride
1,1,2,2-Tetrachloroethane	2-Hexanone	Chlorobenzene	Styrene
1,1,2-Trichloroethane	4-Methyl-2-pentanone	Chloroethane	Tetrachloroethene
1,1-Dichloroethane	Acetone	Chloroform	Toluene
1,1-Dichloroethene	Acrolein	Chloromethane	*trans*-1,2-Dichloroethene
1,2,3-Trichloropropane	Acrylonitrile	*cis*-1,2-Dichloroethene	*trans*-1,3-Dichloropropene
1,2-Dibromo-3-chloropropane—8011	Benzene	*cis*-1,3-Dichloropropene	*trans*-1,4-Dichloro-2-Butene
1,2-Dibromoethane	Bromochloromethane	Dibromochloromethane	Trichloroethene
1,2-Dichlorobenzene	Bromodichloromethane	Dibromomethane	Trichlorofluoromethane
1,2-Dichloroethane	Bromoform	Dimethylbenzene, Total[a]	Vinyl Acetate
1,2-Dichloropropane	Bromomethane	Ethylbenzene	Vinyl Chloride
PCBs—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	PCB-1268
PCB-1221			
Radionuclides—Method U-02-RC M unless noted			
Alpha Activity—9310	**Cobalt-60[b]—901.1**	Uranium-235, Dissolved[b]	**Cesium-137, Dissolved[b]—901.1**
Beta Activity—9310	**Thorium-234[b]—901.1**	Uranium-234, Dissolved[b]	**Cobalt-60, Dissolved[b]—901.1**
Radium-226—AN-1418	**Americium-241[b]—AM-05-RC M**	Uranium-238, Dissolved[b]	**Thorium-234, Dissolved[b]—901.1**
Strontium-90—905.0 M	**Neptunium-237[b]—1475-00aM**	Uranium	**Americium-241, Dissolved[b]—AM-05-RC M**
Technetium-99—TC-02-RC M	**Plutonium-239/240[b]—PU-11-RC M**	Uranium, Dissolved[b]	**Neptunium-237, Dissolved[b]—1475-00aM**
			Plutonium-239/240, Dissolved[b]—PU-11-RC
Thorium-230—Th-01-RC M	Uranium-235[b]	**Dissolved Alpha[b]—9310**	**M**
Tritium—906.0 M	Uranium-234[b]	**Dissolved Beta[b]—9310**	**Thorium-230, Dissolved[b]—Th-01-RC M**
Cesium-137[b]—901.1	Uranium-238[b]	**Technetium-99, Dissolved[b]—TC-02-RC M**	
Radium-228[c]—904.0M	**Thorium-232[c]—Th-01-RC M**		
Metals—Method 6020 unless noted			
Aluminum	Lead	Thallium	Cobalt, Dissolved
Antimony	Magnesium	Tin[b]	Copper, Dissolved
Arsenic	Manganese	Titanium[b]	Lead, Dissolved
Barium	**Mercury—7470A**	Uranium	Manganese, Dissolved
Beryllium	Molybdenum	Vanadium	Nickel, Dissolved
Boron	Nickel	Zinc	Selenium, Dissolved
Cadmium	Potassium	Barium, Dissolved	Silver, Dissolved
Calcium	Rhodium	Chromium, Dissolved	Tin, Dissolved
Chromium	Selenium	Antimony, Dissolved	Titanium, Dissolved
Cobalt	Silver	Arsenic, Dissolved	Uranium, Dissolved
Copper	Sodium	Cadmium, Dissolved	Vanadium, Dissolved
Iron	Tantalum		Zinc, Dissolved
Anions—Method 9056			
Bromide	Fluoride	Nitrate as Nitrogen	Sulfate
Chloride			
Field Parameters			
Conductivity	Redox	Temperature	pH
Dissolved Oxygen			
Miscellaneous—Method as follows			
Total Dissolved Solids—160.1	**Total Organic Halides—9020B**	**Phosphorus[b]—365.4**	**Carbonaceous Biochemical[b]**
Chemical Oxygen Demand—410.4	**Total Organic Carbon—9060A**	**Hardness—Total as $CaCO_3$[b]—130.2**	**Oxygen Demand—SM 5210 B**
Cyanide—9012B	**Oil and Grease[b]—1664A**	**Iodide—300.0**	**Total Suspended Solids[b]—160.2**

[a] Xylenes

[b] Permit does not require analysis of this parameter. The parameter is analyzed in support of leachate treatment and discharge to KPDES Outfalls 004 and 008 at the C-615 Wastewater Treatment Facility.

[c] Permit does not require analysis of radium-228 and thorium-232. These parameters are analyzed in support of demonstrating compliance with DOE Order 458.1 for the C-746-U Landfill.

Bolded parameters are sampled by different method than specified in header.

C-404 Low-Level Radioactive Waste Burial Ground Leachate Monitoring

Frequency: As needed

Driver: The leachate parameters are required to be sampled per the Hazardous Waste Management Facility Permit, Number KY8-890-008-982.

Reported: C-404 Semiannual Groundwater Report and the ASER

Rationale: Hazardous Waste Management Facility Permit, KY8-890-008-982

Comments: Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2020 because it is permit driven.

Leachate analytical parameters for C-404 Landfill are presented in Table C.40.

Table C.40. C-404 Landfill Leachate Analytical Parameters

Volatiles—Method 8260B			
Trichloroethene			
Radionuclides—Method U-02-RC M unless noted			
Technetium-99—TC-02-RC M	Uranium-235	**Plutonium-239/240—PU-11-RC M**	**Cesium-137[a]—901.1**
Uranium-234	Uranium-238	**Thorium-230—Th-01-RC M**	**Neptunium-237—1475-00aM**
PCBs[b]—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	
PCB-1221			
Metals—Method 6020 unless noted			
Barium	Iron	Silver	**Mercury—7470A**
Cadmium	Lead	Zinc	Selenium
Chromium	Nickel	Arsenic	Uranium
Copper			
Miscellaneous—Method as follows			
Fluoride—9056	**Ammonia as Nitrogen—350.1**		
Field Parameters			
pH	Dissolved Oxygen	Redox	Temperature
Conductivity			

[a] Cesium is not required by the Hazardous Waste Management Facility Permit, but is requested per management decision.
[b] PCBs are not required by the Hazardous Waste Management Facility Permit for disposal purposes.
Bolded parameters are sampled by different method than specified in header.

C.5. EXTERNAL GAMMA AND NEUTRON RADIOLOGICAL MONITORING

Frequency: Collected continuously and analyzed quarterly; external gamma dosimeters at 64 monitoring locations and neutron dosimeters at 7 monitoring locations are changed quarterly for external radiation monitoring.

Driver: DOE Order 436.1 and DOE Order 458.1

Reported: ASER

Rationale: Monitor the effective dose from site operations in order to ensure operational limits are not exceeded.

Comments: Figure C.17 shows thermoluminescent dosimeter monitoring locations. The number of locations and frequency were not modified for this program in FY 2020.

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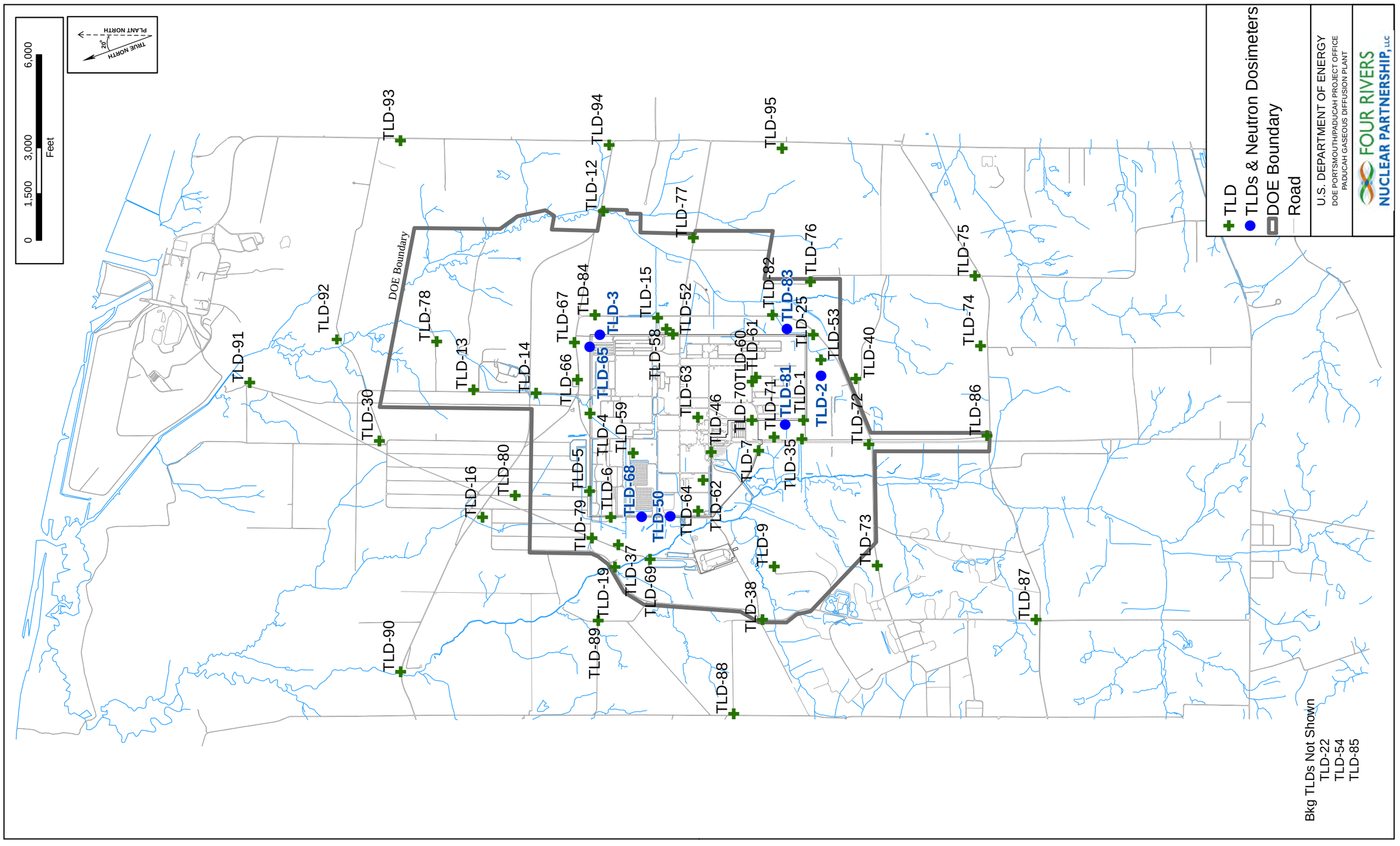

Figure C.17. Environmental Dosimeter Locations

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C.6. AMBIENT AIR MONITORING

Frequency: Weekly and Quarterly

Driver: *National Emission Standards for Hazardous Air Pollutants Management Plan for Emission of Radionuclides for the U.S. Department of Energy Operations at the Paducah Site, Paducah, Kentucky*, PAD-REG-1017, November 2013

Reported: NESHAP Annual Report and ASER

Rationale: Monitor radionuclide emissions from Paducah Site activities.

Comments: Ambient air is monitored to verify the concentrations of radionuclides from all sources, including fugitive and diffuse. The ambient air monitoring network is comprised of nine air monitoring stations surrounding the site, including one background location.

Location identifications are found in Table C.41. Filter samples are collected on a weekly basis and analyzed for gross alpha and beta, as shown in Table C.42. The laboratory retains the filter and compiles all of the weekly samples for each quarterly period. At the end of each quarter, the filters are compiled and analyzed for the isotopes defined in the quarterly analysis table, C.43. Locations are shown on Figure C.18.

Table C.41. Ambient Air Monitoring Locations (9)

AMDBCP (BG)	AMD002	AMD612
AMD57	AMDNE	AMD746S
AMD012	AMD015	AMD746U

BG = Background

Table C.42. Ambient Air Monitoring Weekly Analytical Parameters

Radionuclides—Method 9310	
Alpha Activity	Beta Activity

Table C.43. Ambient Air Monitoring Quarterly Analytical Parameters

Radionuclides—Methods as follows		
Americium-241—AM-05-RC M	**Plutonium-239/240—Pu-11-RC M**	**Uranium-234—U-02-RC M**
Plutonium-238—Pu-11-RC M	**Technetium-99—Tc-02-RC M**	**Uranium-235—U-02-RC M**
Neptunium-237—ASTM-1475-00 M	**Thorium-234/Uranium-238—HASL300 4.5.2.3**	**Uranium-238—U-02-RC M**

Bolded parameters are sampled by different method than specified in header.

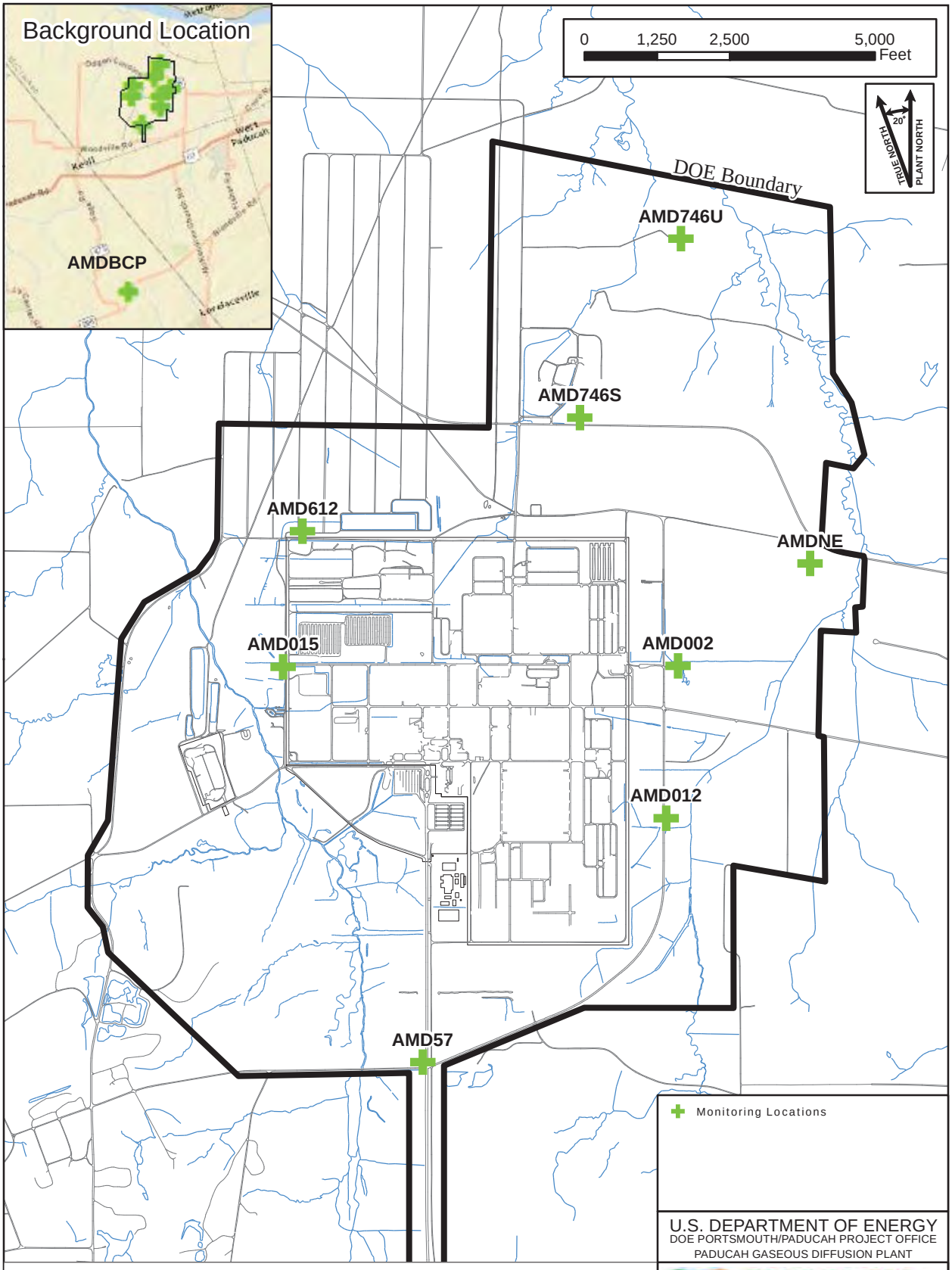

Figure C.18. DOE Ambient Air Monitoring Stations

APPENDIX D

ENVIRONMENTAL MONITORING QUALITY ASSURANCE PROJECT PLAN

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ACRONYMS

CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	chemical (or radionuclide) of potential concern
CPAP	Contractor Performance Assurance Program
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQI	Data Quality Indicator
DQO	data quality objective
ECD	electron capture detector
EDD	Electronic Data Deliverable
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FID	flame ionization detector
FRNP	Four Rivers Nuclear Partnership, LLC
GC	gas chromatography
GC-MS	gas chromatography mass spectrometer
ICP-AES	inductively coupled plasma atomic emission spectroscopy
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LCS	laboratory control sample
MCL	maximum contaminant level
MDA	minimum detectable activity
MDL	method detection limit
MPC	measurement performance criteria
MRL	minimum reporting limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAL	no action level
NDIRD	nondispersive infrared detector
OREIS	Paducah Oak Ridge Environmental Information System
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	polychlorinated biphenyl
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure
SVOC	semivolatile organic compound
TLD	thermoluminescent dosimeter
TOC	total organic carbon
UFP	Uniform Federal Policy

VOC	volatile organic compound
XRF	X-ray fluorescence

INTRODUCTION

The Environmental Monitoring (EM) Quality Assurance Project Plan (QAPP) has been prepared by Four Rivers Nuclear Partnership, LLC, (FRNP) based on the updated programmatic QAPP, DOE/LX/07-2439&D1, *Programmatic Quality Assurance Project Plan*, April 2019, which was developed in alignment with the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP Manual) guidelines for QAPPs, March 2005, as updated by the *Optimized UFP-QAPP Worksheets* guidance, March 2012.

This EM QAPP is Appendix D to the *Environmental Monitoring Plan Fiscal Year 2020*, CP2-ES-0006/FR5. It describes the project-specific quality assurance (QA) activities that will be conducted to support ongoing monitoring programs of varying media (e.g., groundwater, surface water, air, and sediment) at the site.

This EM QAPP does the following:

- Refers to the SOPs already developed for the site and in place;
- Identifies analytical limits, units of reporting, and methods requested by each program; these values will be used to procure laboratory services. If the laboratory cannot meet the limits, units, or methods specified in the QAPP, the project manager and/or compliance organization will be contacted so a determination can be made if the proposed conditions are acceptable to meet current project objectives. If the conditions are found to be acceptable, the Sample Management Office (SMO) will document the acceptance with rationale;
- Identifies analytical limits and methods that may be required by a given project [e.g., permits, maximum contaminant level (MCL), etc.];
- Incorporates the *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities*, DOE/OR/07-1595&D2 (DOE 1998); and
- Standardizes data validation processes by linking the process to SOPs (see Worksheet #21).

This document supports the EM procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Plan*, CP2-ES-0063; and *Developing, Implementing, and Maintaining Data Management Implementation Plans,* CP3-ES-1003.

This QAPP focuses on providing fixed laboratory methods, although Appendix C of the Environmental Monitoring Plan (EMP) identifies field measurements requested on each of the programs. Field methods [e.g., X-ray fluorescence (XRF), colorimetric methods for polychlorinated biphenyls (PCBs), and radionuclide surveys] that may be implemented in support of the programs within this EMP are not covered in either of the discussion of the EMP or within this QAPP.[1]

This QAPP does not cover the analysis of the thermoluminescent dosimeters (TLDs) for gamma emissions although the program is detailed with sample locations in Appendix C of the EMP. Those

[1] Project-specific QAPPs contain information concerning implemented field methods.

analyses are conducted utilizing quality standards set forth and evaluated by the Health, Safety, Security, and Quality (HSS&Q) organization. Additionally, samples collected in the ambient air monitoring program are not covered in this QAPP. While the ambient air program, like the TLD environmental monitoring program, is important for overall evaluation of site operations, it is not considered to fit the typical QAPP guidelines and should not be forced into the parameter listing within the QAPP on the sole reason that they are included in Appendix C of the EMP.

Worksheets #10 and #17 are not included in this QAPP. Based on the programmatic QAPP, completion of these worksheets in project-specific QAPPs is at the discretion of the project. Considering the information is already included in the body of the EMP, the decision was made to not include these worksheets in this QAPP.

Worksheets #12 and #15 were adapted from the programmatic QAPP. Only those worksheets containing parameters required under the EMP and identified in the Risk Methods Document (RMD) as contaminants of concern (COCs) at the site (DOE 2019) were included in this QAPP.

This QAPP provides limited information on some analyses considered as miscellaneous tests. Miscellaneous tests are defined in Worksheet #23. Samples for these analyses are collected using standard operating procedures (SOPs) employed by the sampling staff and quality assurance standards specified in procedures such as CP3-ES-5003, *Quality Assured Data*. They are not listed in Worksheets #12 and #15 because they are not considered COCs at the site. These parameters are requested by programs within Appendix C of the EMP because they are indicators of overall water quality or, in some instances, are required as conditions of permits (e.g., toxicity, ferrous iron, and coliform).

QAPP Worksheets #1 and #2. Title and Approval Page

Site Name/Project Name: Paducah Gaseous Diffusion Plant/Environmental Monitoring
Site Location: Paducah, Kentucky
Site Number/Code: KY8890008982
Contractor Name: FRNP
Contractor Number: Contract No. DE-EM0004895
Contract Title: Paducah Gaseous Diffusion Plant Paducah Deactivation and Remediation Project
Work Assignment Number: N/A

Document Title: *Environmental Monitoring Quality Assurance Project Plan*

Lead Organization: U.S. Department of Energy (DOE)

Preparer's Name and Organizational Affiliation: Lisa Crabtree, Four Rivers Nuclear Partnership, LLC

Preparer's Address, Telephone Number, and E-mail Address: 5511 Hobbs Road, Kevil, KY, 42053, Phone (270) 441-5135, lisa.crabtree@pad.pppo.gov

Preparation Date (Month/Year): 10/2019

Document Control Number: CP2-ES-0006/FR5, Appendix D

FRNP Environmental Services Director	Signature David Hutchison	Date: 10/3/19
FRNP Environmental Stewardship Manager	Signature Kelly Layne	Date: 10/2/19
FRNP Environmental Monitoring and Sample Management Office Project Manager	Signature Lisa Crabtree	Date: 10/2/19
FRNP Quality Assurance Manager	Signature Jennie Freels	Date: 10/3/19

QAPP Worksheets #1 and #2. Title and Approval Page (Continued)

1. Identify guidance used to prepare QAPP:

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Implementing Environmental Quality Systems,* Version 2.0, 126 pages.

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans*: *Part 1 UFP-QAPP Manual,* Version 1.0, 177 pages (DTIC ADA 427785 or EPA-505-B-04-900A).

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans*: *Part 2A UFP-QAPP Workbook,* Version 1.0, 44 pages.

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans: Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities,* Version 1.0, 76 pages.

   Intergovernmental Data Quality Task Force, March 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets,* 42 pages.

   Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1. Human Health (DOE 2019).

   Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2421&D1.

2. Identify regulatory program: The EMP is not submitted to regulatory agencies for review or approval; however, many of the sampling programs defined within the EMP are required by regulatory decision documents, permits or DOE Orders (O); therefore, those regulatory programs are pertinent. They include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707 (FFA); Kentucky Department for Environmental Protection (Kentucky Division of Waste Management, Kentucky Division of Water); and DOE Orders.

3. Identify approval entity: DOE

4. Indicate whether the QAPP is a generic or a project-specific QAPP (circle one).

5. List dates of scoping sessions that were held: July 29, 2019—Data Quality Objective (DQO) Session

QAPP Worksheets #1 and #2. Title and Approved Page (Continued)

6. List dates and titles of QAPP documents written for previous site work, if applicable:

Title:	**Approval Date(s):**
Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities, DOE/OR/07-1595&D2 (DOE 1998)	10/5/1998
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2409&D1	February 2017
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2421&D1	April 2018
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2439&D1	April 2019

7. List organizational partners (stakeholders) and connection with lead organization:
U.S. Environmental Protection Agency (EPA) Region 4 (FFA member); Kentucky Department for Environmental Protection (KDEP) (regulates hazardous and solid waste landfills, effluent discharge permits, FFA member)

8. List data users: DOE, FRNP, subcontractors, EPA Region 4, KDEP

9. Table 1 provides a crosswalk of required QAPP elements.

This QAPP includes 26 combined worksheets that are required based on UFP-QAPP guidance, as updated by the optimized worksheet guidance (37 total worksheets). Worksheets #10 and #17 have been omitted because the problem definitions are described in detail within the body of the Environmental Monitoring Plan, of which this QAPP is an appendix. Each of these worksheets has been reviewed to ensure the accuracy of the information presented in this QAPP.

Table 1. Crosswalk: UFP-QAPP Workbook to 2106-G-05-QAPP

Optimized UFP-QAPP Worksheets		**CIO 2106-G-05 QAPP Guidance Section**	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP ELEMENTS FOR EVALUATING EXISTING DATA
14 & 16	Project Tasks and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection/Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC Summary	2.3.5	Quality Control Requirements
21	Field SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Require
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, & 33	Assessments and Corrective Action	2.4	ASSESSMENTS AND DATA REVIEW (CHECK)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

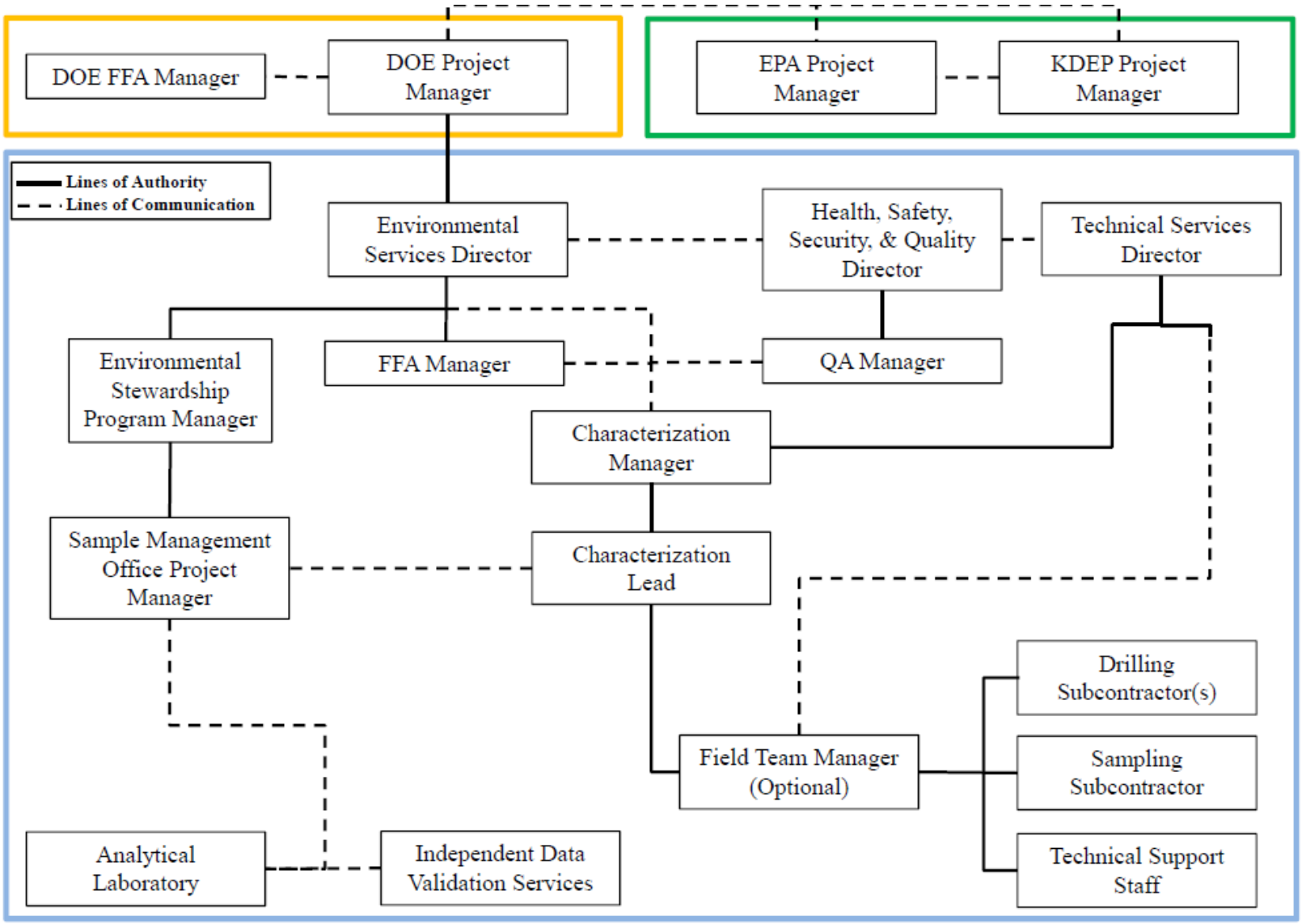
QAPP Worksheets #3 and #5.
Project Organization and QAPP Distribution

Distribution is based on the position title. A change in the individual within an organization will not trigger a resubmittal of the QAPP. DOE may choose to update this worksheet and submit page changes to the document holders. Alternatively, as with other changes to the approved project-specific QAPP, personnel changes may be tracked and included as an attachment to the QAPP. Managers are responsible for distribution to their staffs.

Controlled copies of the QAPP will be distributed according to the distribution list below. This list will be updated, as needed, and kept by the FRNP Records Management Department. Each person receiving a controlled copy also will receive any updates/revisions. If uncontrolled copies are distributed, it will be the responsibility of the person distributing the uncontrolled copy to provide updates/revisions.

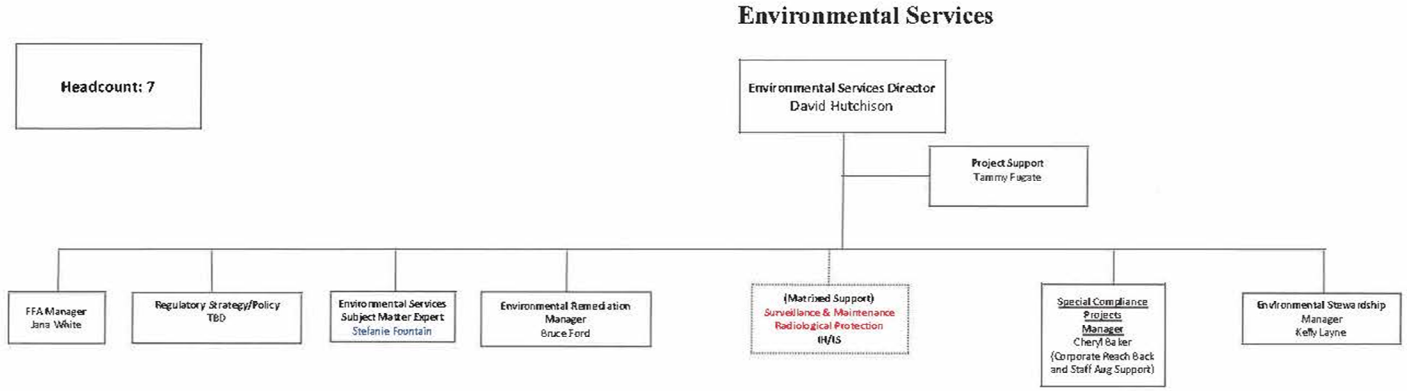
Position Title	Organization	QAPP Recipients	Current Telephone Number	Current E-mail Address	Document Control Number
Paducah Site Lead	DOE	Jennifer Woodard	(270) 441-6820	jennifer.woodard@pppo.gov	1
Project Manager (PM)	DOE	David Dollins	(270) 441-6819	dave.dollins@pppo.gov	2
FFA Manager	DOE	Tracey Duncan	(270) 441-6862	tracey.duncan@pppo.gov	3
Environmental Services Director	FRNP	David Hutchison	(270) 441-5929	dave.hutchison @pad.pppo.gov	4
Environmental Stewardship Manager	FRNP	Kelly Layne	(270) 441-6726	kelly.layne@pad.pppo.gov	5
Environmental Radiation Protection Manager	FRNP	LeAnne Garner	(270) 441-5436	leanne.garner@pad.pppo.gov	6
FFA Manager	FRNP	Jana White	(270) 441-5185	jana.white@pad.pppo.gov	7
QA/Quality Control (QC) Program Manager	FRNP	Jennie Freels	(270) 441-5407	jennie.freels@pad.pppo.gov	8
Environmental Monitoring and Sample Management Office PM	FRNP	Lisa Crabtree	(270) 441-5135	lisa.crabtree@pad.pppo.gov	9
Sample Management Office	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	11

QAPP Worksheets #3 and #5. (Continued)
Project Organization and QAPP Distribution



Note: DOE personnel are in Orange Box, Regulatory personnel are in Green Box, and DOE Prime Contractor personnel are in Blue Box.

QAPP Worksheets #3 and #5. (Continued)
Project Organization and QAPP Distribution



Director Signature: DP Hutchison
David Hutchison

Approved Date: 9-9-19

QAPP Worksheets #4, #7, and #8.
Personnel Qualifications and Sign-Off Sheet

ORGANIZATION: Four Rivers Nuclear Partnership, LLC

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
David Hutchison	Environmental Services Director	> 4 years relevant work experience	No specialized training or certification. See Training Position Description (TPD).	
Kelly Layne	Environmental Stewardship Manager	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Lisa Crabtree	Environmental Monitoring and Sample Management Office PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jaime Morrow	Sample Management Office	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jason Boulton	Sample Team Leader	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Susan Kon	Data Validator	Bachelor degree plus relevant experience	No specialized training or certification.	Follows FRNP data validation plans
LeAnne Garner	Environmental Radiation Protection Manager	> 4 years relevant work experience	No specialized training or certification. See TPD.	

ORGANIZATION: Laboratory

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
Laboratory Project Manager	Analytical Laboratory Project Manager	> 4 years relevant work experience	No specialized training or certification. See TPD.	Follows the laboratory statement of work

*Signature indicates personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #6.
Communication Pathways

NOTE: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as e-mail, telephone calls, meetings, etc., will occur throughout the project. Regular project communication among DOE, the Site Contractor, and the regulatory agencies concerning project progress is expected. Deviations from the EMP/QAPP will be communicated upward through the chain of command to regulatory agencies using communication tools commensurate with the issue.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	DOE, EPA, KDEP	DOE Site Lead: Jennifer Woodard	jennifer.woodard@pppo.gov	Formal communication among DOE, EPA, and KDEP.
Field progress reports	FRNP	FRNP Environmental Services Director: David Hutchison	dave.hutchison@pad.pppo.gov	Formal communication between DOE and contractor for the Environmental Monitoring Project.
Stop work due to safety issues	FRNP	FRNP Environmental Services Director: David Hutchison and FRNP HSS&Q Director: Bob Macfarlane	dave.hutchison@pad.pppo.gov bob.macfarlane@pad.pppo.gov	FRNP will communicate work stoppages to DOE PM as required by procedure.
QAPP changes during project execution	FRNP	FRNP Environmental Services Director: David Hutchison and FRNP QA Manager: Jennie Freels	dave.hutchison@pad.pppo.gov jennie.freels@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA.
Field corrective actions	FRNP	FRNP Environmental Services Director: David Hutchison	dave.hutchison@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs.
Analytical laboratory interface	FRNP	FRNP Environmental Monitoring and Sample Management Office PM: Lisa Crabtree	lisa.crabtree@pad.pppo.gov	Communication between FRNP and analytical laboratory.

QAPP Worksheet #6. (Continued)
Communication Pathways

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Laboratory quality control variances	Contracted Laboratory	Laboratory PM: Valerie Davis (GEL), Jayna Awalt (TestAmerica), Shain Schmitt (Pace)	vsd@gel.com jayna.awalt@testamericainc.com sschmitt@pacenational.com	Notify FRNP SMO. SMO will notify FRNP PM to determine corrective actions.
Analytical corrective actions	Contracted Laboratory, FRNP	Laboratory PM: Valerie Davis (GEL), Jayna Awalt (TestAmerica), Shain Schmitt (Pace), FRNP Environmental Monitoring and Sample Management Office PM: Lisa Crabtree	vsd@gel.com jayna.awalt@testamericainc.com sschmitt@pacenational.com lisa.crabtree@pad.pppo.gov	Notify FRNP SMO. FRNP SMO will notify the project.
Data verification issues (e.g., incomplete records)	Veolia Nuclear Solutions Federal Services, FRNP	Data Validator: Susan Kon, FRNP Environmental Monitoring and Sample Management Office PM: Lisa Crabtree	Susan_L_Kon@rl.gov lisa.crabtree@pad.pppo.gov	Data verification issues will be reported to the FRNP SMO.
Data validation issues (e.g., noncompliance with procedures)	Veolia Nuclear Solutions Federal Services, FRNP	Data Validator: Susan Kon, FRNP Environmental Monitoring and Sample Management Office PM: Lisa Crabtree	Susan_L_Kon@rl.gov lisa.crabtree@pad.pppo.gov	Issues with data quality will be reported to the FRNP SMO.

NOTE: This QAPP is position-based with names of the current positions presented. In the event the contractor changes and the position titles change, DOE will notify EPA and KDEP of the change.

QAPP Worksheet #9.
Project Planning Session Summary

Project scoping is the key to the success of any project and is part of the systematic planning process. The preparation of this QAPP included review of past documents produced and planning meetings to establish the objectives of the project. It was determined that a formal DQO session was needed for the FY 2020 EMP. The worksheet identifies participants who discussed the sampling strategy in the DQO session held on July 29, 2019.

Name of Project: Environmental Monitoring Plan Fiscal Year 2020
Date of Session: July 29, 2019
Scoping Session Purpose: Identify sampling strategies of EM programs

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	DOE	David Dollins	270-441-6819	dave.dollins@pppo.gov	Project Management
Project Manager Risk	DOE	Rich Bonczek	859-219-4051	rich.bonczek@pppo.gov	Subject Matter Expert
Project Manager	DOE	Tracey Duncan	270-441-6862	tracey.duncan@pppo.gov	Project Management
Scientist	Pro2Serve	Tracy Taylor	270-441-6866	tracy.taylor@pppo.gov	Subject Matter Expert
Scientist	Pro2Serve	Jennifer Johnson	270-441-6846	jennifer.johnson@pppo.gov	Subject Matter Expert
Scientist	Pro2Serve	George Butterworth	270-441-6803	george.butterworthIII@pppo.gov	Subject Matter Expert
Risk Support	SMSI	Martin Clauberg	865-259-7155	martin.claubergt@pppo.gov	Subject Matter Expert
Environmental Services Director	FRNP	David Hutchison	270-441-5929	dave.hutchison@pad.pppo.gov	Environmental Services
Environmental Monitoring and Sample Management Office Manager	FRNP	Lisa Crabtree	270-441-5135	lisa.crabtree@pad.pppo.gov	Project Management, Laboratory and Sampling Requirements

QAPP Worksheet #9. (Continued)
Project Planning Session Summary

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Environmental Stewardship Manager	FRNP	Kelly Layne	270-441-6726	kelly.layne@pad.pppo.gov	Project Management
Regulatory Compliance Manager	FRNP	Dennis Greene	270-441-5071	dennis.greene@pad.pppo.gov	Regulatory Compliance
Environmental Radiation Protection Manager	FRNP	LeAnne Garner	270-441-5436	leanne.garner@pad.pppo.gov	Project Management
Project Support	FRNP	Teresa Overby	270-441-5188	teresa.overby@pad.pppo.gov	Subject Matter Expert
Project Support	FRNP	Ken Davis	270-441-5049	ken.davis@pad.pppo.gov	Subject Matter Expert

Notes/comments: Discussed proposed changes to sampling programs in Appendix C for FY 2020 EMP and that the draft EMP would be submitted to DOE for review by September 1, 2019.

Consensus decisions made: Submit draft FY 2020 EMP by September 1, 2019 for DOE review and comment.

Action items:

Action	Responsible Party	Due Date
Submit draft FY 2020 EMP	Lisa Crabtree	9/1/2019

QAPP Worksheet #11.
Project/Data Quality Objectives

Step 1. State the Problem:

Problem Statement: Determine environmental monitoring requirements set forth by the following drivers:

DOE Order (O) 450.1A, Environmental Protection Program
DOE O 458.1, Radiation Protection of the Public and the Environment
DOE-HDBK-1216-2015, Environmental Radiological Effluent Monitoring and Environmental Surveillance
Kentucky Permits
CERCLA Actions
FFA

Problem Approach:

- The planning team will review plans, regulations, DOE orders, and permits to determine monitoring requirements.
- Planning Team: DOE and FRNP
- Determine Resources:
  - Schedule: implement FY 2020 EMP, October 1, 2019
  - Budget: Based upon scope
  - Personnel: FRNP

Step 2: Identify the Goal of the Study

Obtain data to:

- Demonstrate compliance (effluent, rad dose, etc.)
- Demonstrate effectiveness of chosen remedy (Pump & Treat, etc.)
- Provide for modeling efforts (groundwater surveillance)
- Identify potential adverse environmental impacts; supporting Integrated Safety Management System (ISMS) through an Environmental Management System (EMS)

Data required to be reported via permits or other regulatory decision documents will be reported as required (Appendix C of the EMP lists applicable reports).

QAPP Worksheet #11.
Project/Data Quality Objectives

Step 3. Identify Information Inputs:

Identify Information Inputs (What Information Do We Need)

- Permit or decision document specifies parameters and frequency for demonstration of compliance and remedy effectiveness
- Models and historical data sets provide for data needs

Step 4. Identify the Boundaries of the Study:

Permits, chosen remedies, and modeling are ongoing until permit modifications or final remedies are chosen or demonstrated.

Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process consistent with procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Plan*, CP2-ES-0063; and *Developing, Implementing, and Maintaining Data Management Implementation Plans*, CP3-ES-1003.

Step 5. Develop the Analytical Approach:

Identify methods, parameters, project action limits, method detection limits, sample locations, sample frequencies.

Required list of analytes is specified by program within Appendix C of the EMP. Both field screening and on-site and off-site laboratory analyses are used for data collection.

Step 6. Specify Performance or Acceptance Criteria:

Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process consistent with procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Plan*, CP2-ES-0063; and *Developing, Implementing, and Maintaining Data Management Implementation Plans*, CP3-ES-1003.

Obtained data may:

- Provide data for use in the ASER
- Identify DOE operations pollutant contributions
- Provide ancillary data that may be required to assess the consequences of a spill or release

QAPP Worksheet #11. (Continued)
Project/Data Quality Objectives

- Identify significant changes in sample analytical results
- Support or supplement data needs for CERCLA actions
- Provide a mechanism for long-term data collection needs under the FFA

EMP does not address reports or modeling development or a show of noncompliance. Example: An exceedance at a Kentucky Pollutant Discharge Elimination System (KPDES) outfall does not indicate an objective within the EMP was not met.

Step 7. Develop the Detailed Plan for Obtaining Data:

- Procedures and Plans
- Analytical Methods
- Statements of Work
- DOECAP Laboratories
- *Environmental Monitoring Data Management Implementation Plan*
- Paducah Project Environmental Measurements System, Oak Ridge Environmental Information System (OREIS), PPPO Environmental Geographic Analytical Spatial Information System (PEGASIS)

QAPP Worksheet #12-A.
Measurement Performance Criteria (PCBs, Sediment)

Matrix	Sediment
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8082 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy	RPD—≤ 40%	Dual column analysis	A
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-B.
Measurement Performance Criteria (Radionuclides, Sediment)

Matrix	Sediment
Analytical Group[1]	Radionuclides (uranium[8], uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Alpha spectroscopy[7] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's Standard Operating Procedure (SOP); however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.
[8] The total uranium listed represents the total of the uranium isotopes that is analyzed by alpha spectroscopy.

QAPP Worksheet #12-C.
Measurement Performance Criteria (Radionuclides, Sediment)

Matrix	Sediment
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Alpha spectroscopy[7] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-D.
Measurement Performance Criteria (Radionuclides, Sediment)

Matrix	Sediment
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Gamma spectroscopy[6] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-E.
Measurement Performance Criteria (Radionuclides, Sediment)

Matrix	Sediment
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Liquid scintillation[7] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-F.
Measurement Performance Criteria (VOCs, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8260 and EPA-624.1 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-G.
Measurement Performance Criteria (Metals, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Metals (all except mercury)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	EPA-200.8/ SW-846-6010/6020 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias	RPD = 80-120%	Interference Check Sample	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-H.
Measurement Performance Criteria (Mercury, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-7470 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-I.
Measurement Performance Criteria (PCBs, Water)

Matrix	Water/Groundwater
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8082 and EPA-608.3 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy	RPD—≤ 40%	Dual column analysis	A
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-J.
Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230, uranium,[8] uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Alpha spectroscopy[7] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

[4] Appendix C contains the version of the analytical method to be used.

[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

[8] The total uranium listed represents the total of the uranium isotopes that is analyzed by alpha spectroscopy.

QAPP Worksheet #12-K.
Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Gamma spectroscopy[6] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-L.
Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Liquid scintillation[7] See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-M.
Measurement Performance Criteria (SVOCs, Water)

Matrix	Water/Groundwater
Analytical Group[1]	SVOCs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8270 See Worksheet #23	Precision—Lab	RPD—< 25%	Laboratory Duplicates	A
		Precision	RPD—< 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] Appendix C contains the version of the analytical method to be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

QAPP Worksheet #12-N.
Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/Groundwater
Analytical Group[1]	Radionuclides / Water Policy (uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Inductively coupled plasma-mass spectroscopy[7] See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

[4] Appendix C contains the version of the analytical method to be used.

[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #13.
Secondary Data Uses and Limitations

Secondary Data Type	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Factors Affecting Reliability and Limitations on Data Use
OREIS Database	Various	Various	Data will be used to determine the nature and extent of sediment, surface water, and groundwater contamination.	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used if there is sufficient time to resample and obtain a result that will not be rejected during validation.
Historical Documentation	Various	Various	Information will be used as guidance on related project work.	Information from historical documents will be limited to the available documentation as it relates to a specific project. Use of historical data may be limited based on how long ago the data were collected and whether site conditions have changed since data collection.

NOTE; OREIS is the repository for PGDP environmental and waste characterization analytical results. OREIS is a limited access database. Environmental data are downloaded from OREIS to PEGASIS periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

QAPP Worksheets #14/16.
Project Tasks & Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Routine sampling conducted throughout the fiscal year	FRNP	October 1, 2019	September 30, 2020	See Appendix C of the EMP for deliverable information	See Appendix C of the EMP for deliverable information.

QAPP Worksheet #15.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

The application of Worksheet #15 should be evaluated via a graded approach because the sampling dictated within the EMP is with the objective of monitoring and not as a site investigation or remediation effort wherein an "action limit" may appropriately describe the objective of the sampling efforts.

For example, Worksheets #15A through #15F pertain to the parameters of groundwater; however, trichloroethene (TCE) detected in a groundwater well located in the close proximity to the DOE boundary that had never shown TCE may have a differing response action than a response to the exact same TCE concentration in a well located within the groundwater plume which has shown TCE at or above that concentration since monitoring commenced in the 1990s. A better approach would be comparing the data sets to the historical data for the specific locations in question.

Worksheets #15A through #15I combine groundwater and surface water information. Laboratory methods for groundwater and surface water typically do not vary. Action limits between the two may differ. For example, the laboratory will use the same method for the requested analytes on a groundwater sample as they do on a surface water sample regardless if it was collected from a groundwater monitoring well or from an effluent outfall location. But, response actions to the same concentration for a given parameter may or may not differ between the two samples because it would be dependent upon the program under which it is monitored and the location from where the samples were collected. Therefore, the matrices for "water" in the following spreadsheets are shown with groundwater being the primary driver with the exception of the last worksheet, Worksheet #15-I, which specifically addresses the surface water samples required by KPDES permit that have a permit limit associated with the parameter excluding toxicity. The action limits included in worksheets #15A through #15I are well below MCL or derived concentration technical standard values. These action limits were included in the Programmatic QAPP for those projects that perform routine monitoring. These limits will allow those projects to evaluate trends at lower concentrations successfully.

QAPP Worksheet #15-A.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Water)

Matrix: Water
Analyte Group: VOCs

VOC	Chemical Abstracts Service (CAS) Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL (µg/L)
Acrylonitrile	107-13-1	0.052/0.0523	Tapwater[d]/NAL	Yes	5	1.5
Benzene	71-43-2	5.0/0.455	MCL/NAL	Yes	1	0.3
Carbon tetrachloride	56-23-5	5.0/0.455	MCL/NAL	Yes	1	0.3
Chloroform	67-66-3	80/0.221	MCL/NAL	Yes	1	0.3
1,1-Dichloroethene	75-35-4	7.0/28.5	MCL/NAL	Yes	1	0.3
cis-1,2-Dichloroethene	156-59-2	70/3.61	MCL/NAL	Yes	1	0.3
trans-1,2-Dichloroethene	156-60-5	100/9.29	MCL/NAL	Yes	1	0.3
Ethylbenzene	100-41-4	700/1.50	MCL/NAL	Yes	1	0.3
Tetrachloroethene	127-18-4	5.0/4.06	MCL/NAL	Yes	1	0.3
Trichloroethene	79-01-6	5.0/0.283	MCL/NAL	Yes	1	0.3
Vinyl Chloride	75-01-4	2.0/0.0188	MCL/NAL	Yes	1	0.3

QAPP Worksheet #15-A. (Continued)
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

VOC	CAS Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL (µg/L)
Total Xylenes	1330-20-7	10,000/19.3	MCL/NAL	Yes	1	0.3
o-Xylene	95-47-6	19/19.3	Tapwater[d]/NAL	Yes	1	0.3
m,p-Xylene	179601-23-1	19/19.3[e]	Tapwater[d]/NAL	Yes	2	0.3

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level (see EPA 2016)
MDL = method detection limit
NAL = no action level for child resident scenario taken from the 2019 RMD
PQL = practical quantitation limit
VOC = volatile organic compound

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2019a) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2018 (EPA 2018).
[e] Project action limit for m-Xylene used.

QAPP Worksheet #15-B.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Water)

Matrix: Water
Analytical Group: Metals

Metal	CAS Number	Project Action Limit/NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/L)	MDL (mg/L)
Aluminum	7429-90-5	2.0/2.00	Tapwater[d]/NAL	Yes	0.05	0.0193
Antimony	7440-36-0	0.0060/0.000779	MCL/NAL	Yes	0.003	0.001
Arsenic	7440-38-2	0.010/0.0000517	MCL/NAL	Yes	0.005	0.002
Barium	7440-39-3	2.0/0.377	MCL/NAL	Yes	0.002	0.00067
Beryllium	7440-41-7	0.0040/0.00246	MCL/NAL	Yes	0.0005	0.0002
Boron	7440-42-8	0.40/0.399	Tapwater[d]/NAL	Yes	0.015	0.0052
Cadmium	7440-43-9	0.0050/0.000922	MCL/NAL	Yes	0.001	0.0003
Chromium (total)	7440-47-3	0.10/2.25[e]	MCL/NAL	Yes	0.01	0.003
Cobalt	7440-48-4	0.0006/0.000601	Tapwater[d]/NAL	Yes	0.001	0.0003
Copper	7440-50-8	1.3/0.0799	MCL/NAL	Yes	0.001	0.0003
Iron	7439-89-6	1.4/1.40	Tapwater[d]/NAL	Yes	0.1	0.033
Lead	7439-92-1	0.015/0.0150	MCL[f]/NAL	Yes	0.002	0.0005
Manganese	7439-96-5	0.043/0.0434	Tapwater[d]/NAL	Yes	0.005	0.001

QAPP Worksheet #15-B. (Continued)
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analytical Group: Metals

Metal	CAS Number	Project Action Limit/ NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/L)	MDL (mg/L)
Mercury	7439-97-6	0.0020/0.000566[g]	MCL/NAL	Yes	0.0002	0.000067
Molybdenum	7439-98-7	0.010/0.00998	Tapwater[d]/NAL	Yes	0.0005	0.0002
Nickel	7440-02-0	0.039/0.0392[g]	Tapwater[d]/NAL	Yes	0.002	0.0006
Selenium	7782-49-2	0.050/0.00998	MCL/NAL	Yes	0.005	0.002
Silver	7440-22-4	0.0094/0.00941	Tapwater[d]/NAL	Yes	0.001	0.0003
Thallium	7440-28-0	0.0020/0.000020[g]	MCL/NAL	Yes	0.002	0.0006
Uranium	7440-61-1	0.030/0.000399[g]	MCL/NAL	Yes	0.0002	0.000067
Vanadium	7440-62-2	0.0086/0.00864	Tapwater[d]/NAL	Yes	0.01	0.0033
Zinc	7440-66-6	0.60/0.600	Tapwater[d]/NAL	Yes	0.01	0.0033

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the 2019 RMD
PQL = practical quantitation limit

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD (DOE 2019a) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater-Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2018.
[e] An NAL is not available for chromium (total); therefore, the NAL for chromium III was used.
[f] The MCL established by the EPA for lead is based on a treatment technique action level of 0.015 mg/L.
[g] The PAL/NAL values were derived for metal salts; the CAS number is presented for the elemental form.

QAPP Worksheet #15-C.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Water)

Matrix: Water
Analytical Group: PCBs

PCB	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQLs (µg/L)	MDLs (µg/L)
Total PCBs	1336-36-3	0.50/0.0436	MCL/NAL	Yes	0.1	0.0333
Aroclor-1016	12674-11-2	0.50[d]/0.140	MCL/NAL	Yes	0.1	0.0333
Aroclor-1221	11104-28-2	0.50[d]/0.00471	MCL/NAL	Yes	0.1	0.0333
Aroclor-1232	11141-16-5	0.50[d]/0.00471	MCL/NAL	Yes	0.1	0.0333
Aroclor-1242	53469-21-9	0.50[d]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1248	12672-29-6	0.50[d]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1254	11097-69-1	0.50[d]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1260	11096-82-5	0.50[d]/0.00785	MCL/NAL	Yes	0.1	0.0333

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the 2019 RMD
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD (DOE 2019a) for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] MCL for Total PCBs.

QAPP Worksheet #15-D.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

Matrix: Water
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c] MDAs (pCi//L)
Americium-241	14596-10-2	0.504	NAL	Yes	1
Cesium-137[f]	10045-97-3	1.71	NAL	Yes	10 (75[d])
Neptunium-237[f]	13994-20-2	0.763	NAL	Yes	1 (8[d])
Plutonium-238	13981-16-3	0.398	NAL	Yes	1 (4[d])
Plutonium-239/240	15117-48-3/14119-33-6	0.387	NAL	Yes	1 (4[d])
Technetium-99	14133-76-7	4 mrem/year-dose[e] , 900/19.0	MCL/NAL	Yes	25 (50[d])
Thorium-230	14269-63-7	0.572	NAL	Yes	1 (4[d])
Uranium-234[f]	13966-29-5	10.24/0.739	MCL[f]/NAL	Yes	1 (17[d])
Uranium-235[f]	15117-96-1	0.466/0.728	MCL[f]/NAL	Yes	1 (18[d])
Uranium-238[f]	24678-82-8	9.99/0.601	MCL[f]/NAL	Yes	1 (19[d])

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDA = minimum detectable activity
NAL = no action level for child resident scenario from the 2019 RMD

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD (DOE 2019a) for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.

[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.

[c] The analytical laboratory may not be able to meet NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.

[d] The value in parentheses reflects MDAs requested under the Environmental Radiation Protection Program.

[e] The value derived by the EPA from the 4 mrem/year MCL for Tc-99 is 900 pCi/L (see http://www.epa.gov/reg-flex/radionuclides-drinking-water-small-entity-compliance-guide-february-2002). An alternate value derived by the EPA from the 4 mrem/year MCL is 3,790 pCi/L and was proposed in the July 18, 1991, *Federal Register*, http://nepis.epa.gov (document number 570-Z-91-049).

[f] PAL/NAL was derived considering the contribution from short-lived decay products.

QAPP Worksheet #15-E.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

Matrix: Water
Analytical Group: Radionuclides / Water Policy

Radionuclide	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c] MDLs (mg/L)
Uranium-234	13966-29-5	0.030/0.000399	MCL[d]/NAL[d]	Yes	0.000005
Uranium-235	15117-96-1	0.030/0.000399	MCL[d]/NAL[d]	Yes	0.0005
Uranium-238	24678-82-8	0.030/0.000399	MCL[d]/NAL[d]	Yes	0.003

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the 2019 RMD

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD (DOE 2019a) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] MCL and NAL for Total Uranium.

QAPP Worksheet #15-F.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (SVOCs, Water)

Matrix: Water
Analyte Group: SVOCs

SVOC	Chemical Abstracts Service (CAS) Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL (µg/L)
Benz[a]anthracene	56-55-3	0.03/0.0298	Tapwater[d]/NAL	Yes	1	0.3
Benzo[a]pyrene	50-32-8	0.2/0.0251	MCL/NAL	Yes	1	0.44
Benzo[b]fluoranthene	205-99-2	0.25/0.251	Tapwater/NAL	Yes	1	0.3
Benzo[k]fluoranthene	207-08-9	2.5/2.51	Tapwater/NAL	Yes	1	0.3
Chrysene	218-01-9	25/25.1	Tapwater/NAL	Yes	1	0.3
Dibenz[a,h]anthracene	53-70-3	0.025/0.0251	Tapwater/NAL	Yes	1	0.3
Indeno[1,2,3-cd]pyrene	193-39-5	0.25/0.251	Tapwater/NAL	Yes	1	0.3

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level (see EPA 2016)
MDL = method detection limit
NAL = no action level for child resident scenario taken from the 2019 RMD
PQL = practical quantitation limit
SVOC = volatile organic compound

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2019a) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2018 (EPA 2018).

QAPP Worksheet #15-G.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Sediment)

Matrix: Sediment
Analytical Group: PCBs

PCB	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/kg)	MDL (mg/kg)
Total PCBs	1336-36-3	0.0788	NAL	Yes	0.0033	0.001099
Aroclor-1016	12674-11-2	0.206	NAL	Yes	0.0033	0.001099
Aroclor-1221	11104-28-2	0.0752	NAL	Yes	0.0033	0.001099
Aroclor-1232	11141-16-5	0.0708	NAL	Yes	0.0033	0.001099
Aroclor-1242	53469-21-9	0.0791	NAL	Yes	0.0033	0.001099
Aroclor-1248	12672-29-6	0.0792	NAL	Yes	0.0033	0.001099
Aroclor-1254	11097-69-1	0.0588	NAL	Yes	0.0033	0.001099
Aroclor-1260	11096-82-5	0.0803	NAL	Yes	0.0033	0.001099

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the 2019 RMD
PQL = practical quantitation limit
PCBs = polychlorinated biphenyls

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD (DOE 2019a) for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.

[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP..

[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.

QAPP Worksheet #15-H.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Sediment)

Matrix: Sediment
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]
					MDA (pCi/g)
Americium-241	14596-10-2	1.75	NAL	Yes	1
Cesium-137[d]	10045-97-3	0.0402	NAL	Yes	0.1
Neptunium-237[d]	13994-20-2	0.0911	NAL	Yes	1
Plutonium-238	13981-16-3	4.27	NAL	Yes	1
Plutonium-239/240	15117-48-3/ 14119-33-6	3.77/3.80	NAL	Yes	1
Technetium-99	14133-76-7	110	NAL	Yes	5
Thorium-230	14269-63-7	4.93	NAL	Yes	1
Uranium-234	13966-29-5	5.77	NAL	Yes	1
Uranium-235[d]	15117-96-1	0.148	NAL	Yes	1
Uranium-238[d]	24678-82-8	0.556	NAL	Yes	1

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDA = minimum detectable activity
NAL = no action level for child resident scenario from the 2019 RMD

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

[a] This QAPP references the NALs established by the RMD and MCLs reproduced in the RMD to support project planning and identify whether lower reporting limits may be needed for some constituents. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process within the project-specific QAPP.
[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the MDA is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] PAL/NAL was derived considering the contribution from short-lived decay products.

QAPP Worksheet #15-I.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (KPDES Parameters, Surface Water)

Matrix: Surface Water
Analyte Group: KPDES permit

KPDES Parameters with Permit Limits	CAS Number	Project Action Limit	Outfall	Site COPC?[a]	Laboratory-Specific	
					PQL	MDL
Total Suspended Solids	N/A	30 mg/L	Outfall 001, Outfall 004, Outfall 006, Outfall 013, Outfall 019, Outfall 020, C001	No	5 mg/L	1 mg/L
Oil & Grease	N/A	10 mg/L	Outfall 001, Outfall 006, Outfall 013, Outfall 019, Outfall 020, C001	No	7 mg/L	3.5 mg/L
Aroclor-1016	12674-11-2	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1221	11104-28-2	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1232	11141-16-5	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1242	53469-21-9	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1248	12672-29-6	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L

QAPP Worksheet #15-I. (Continued)
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Surface Water
Analyte Group: KPDES permit

KPDES Parameters with Permit Limits	CAS Number	Project Action Limit	Outfall	Site COPC?[a]	Laboratory-Specific	
					PQL	MDL
Aroclor-1254	11097-69-1	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1260	11096-82-5	500 ng/L	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Zinc	7440-66-6	119 µg/L	Outfall 013	Yes	10 µg/L	3.5 µg/L
Biochemical Oxygen Demand	N/A	30 mg/L	Outfall 004	No	2 mg/L	1 mg/L

[a] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2019a) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP..

QAPP Worksheet #18.
Sampling Locations and Methods

Worksheet #18 provides information pertaining to sampling planned for this project.

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Concentration Level[b]	Number of Samples (Identify Field Duplicate %)	Sampling SOP Reference[c]	Rationale for Sampling Location
Sitewide (see Appendix C of the EMP for specific locations)	Sediment	Surface (Creek Bed Samples)	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	See Worksheet #21	See Appendix C of the EMP
	Surface Water	Surface Water in Creeks and Effluent Discharge	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	See Worksheet #21	
	Groundwater	UCRS, URGA, LRGA	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	See Worksheet #21	

[a] See Analytical SOP References Table (Worksheet #23).
[b] If historic data provide information on anticipated concentration, that information will be populated on this sheet.
[c] See Field SOP References Table (Worksheet #21).

SOP = standard operating procedure
N/A = not applicable
UCRS = Upper Continental Recharge System
URGA = Upper Regional Gravel Aquifer
LRGA = Lower Regional Gravel Aquifer

QAPP Worksheets #19 and #30.
Sample Containers, Preservation, and Hold Times

Laboratory: GEL Laboratories, LLC, 2040 Savage Road, Charleston, SC 29407, Valerie Davis, vsd@gel.com, (843) 556-8171

Pace Analytical, 12065 Lebanon Road, Mt. Juliet, TN 37122, Shain Schmitt, sschmitt@pacenational.com, (615) 773-7549

List any required accreditations/certifications (requirement dependent upon analysis performed): DOECAP, KPDES Wastewater Laboratory Certification. The laboratories supporting the Environmental Monitoring program hold different certifications.

Back-up Laboratory: TestAmerica Laboratories, Inc., 13715 Rider Trail North, Earth City, MO 63045, Jayna Awalt, jayna.awalt@testamericainc.com, (314) 298-8566

Sample Delivery Method: Direct Delivery or Overnight/Federal Express or UPS (United Parcel Service) in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date[a]	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
VOCs[b]	Water	See Worksheet #23	2/14/2021	3 × 40 mL Glass VOA Vial	HCl pH < 2, 0-6°C, no headspace	N/A	14 days for preserved	28 days
SVOCs	Water	See Worksheet #23	2/14/2021	2 × 1,000 ml amber glass	0-6°C	7 days	40 days	28 days
Metals/ Radionuclides by ICP-MS	Water	See Worksheet #23	2/14/2021	1 liter Plastic	HNO_3 pH < 2	N/A	180 days	28 days
Mercury	Water	See Worksheet #23	2/14/2021	N/A	HNO_3 pH < 2	N/A	28 days	28 days
Anions	Water	See Worksheet #23	2/14/2021	125 mL Plastic	0-6°C	N/A	28 days (2 days for nitrate)	28 days
PCBs	Water	See Worksheet #23	2/14/2021	1 liter Amber Glass	0-6°C	N/A	N/A[d]	28 days

QAPP Worksheets #19 and #30. (Continued)
Sample Containers, Preservation, and Hold Times

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date[a]	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
Radionuclides	Water	See Worksheet #23	2/14/2021	3 × 1 liter Plastic	HNO_3 pH < 2[c]	N/A	180 days	28 days
PCBs	Sediment	See Worksheet #23	2/14/2021	125 mL wide-mouth Amber Glass	0–6°C	N/A	N/A[d]	28 days
Radionuclides	Sediment	See Worksheet #23	2/14/2021	500 mL wide-mouth Plastic Straight Side	0–6°C	N/A	180 days	28 days

NOTE: Sample volume and container requirements will be specified by the laboratory. This table includes standard requirements for routine analytical groups.
*See Analytical SOP References table (Worksheet #23).
[a] Indicate the FRNP Approved Suppliers List expiration date.
[b] For C-746-S&T and C-746-U Landfills groundwater samples, VOCs are collected in unpreserved vials with a 7-day holding time due to acrolein and acrylonitrile.
[c] Check with specific laboratory conducting analyses to ensure that acidification will not interfere with laboratory procedures.
[d] A 45-day holding time is an expectation of the laboratory; however, since SW-846 does not indicate a holding time for PCBs, any data that exceeds the 45 days will be identified, but not qualified.
HCl = hydrochloric acid; HNO_3 = nitric acid
ICP-MS = inductively coupled plasma mass spectrometer

QAPP Worksheet #20.
Field Quality Control Sample Summary Table

This worksheet provides a summary of the types of samples to be collected and analyzed for the project.

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Sediment	PCBs	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP
Sediment	Radionuclides	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP
Water (Groundwater and Surface Water)	VOCs	See Appendix C of EMP	5%	5%	5%	5%	5%	1 per day or 1 per cooler containing VOC samples	N/A	See Appendix C of EMP
Water (Groundwater)	SVOCs	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP
Water (Groundwater and Surface Water)	Metals	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP
Water (Groundwater and Surface Water)	PCBs	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP
Water (Groundwater and Surface Water)	Radionuclides	See Appendix C of EMP	5%	5%	5%	5%	5%	N/A	N/A	See Appendix C of EMP

PCB = polychlorinated biphenyl
VOC = volatile organic compound
SVOC = semivolatile organic compound
N/A = not applicable

QAPP Worksheet #21.
Project Sampling SOP References Table

SOPs to be used on this project are summarized below.

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1	CP4-ES-0043, *Temperature Control for Sample Storage* (1/3/2019)	Contractor	Sampling	N	N/A
2	CP2-WM-0001, *FRNP Waste Management Plan* (10/29/2018)	Contractor	N/A	N	N/A
3	CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
4	CP2-ES-0811, *Pesticide and PCB Analyses Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
5	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)* (12/21/2017)	Contractor	N/A	N	N/A
6	CP2-ES-0063, *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (7/3/2019)	Contractor	N/A	N	N/A
7	CP4-ES-2100, *Groundwater Measurement* (1/3/2019)	Contractor	Sampling	N	N/A
8	CP4-ES-2101, *Groundwater Sampling* (1/10/2018)	Contractor	Sampling	N	N/A
9	CP4-ES-2203, *Surface Water Sampling* (1/4/2018)	Contractor	Sampling	N	N/A
10	CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* (1/18/2018)	Contractor	Sampling	N	N/A
11	CP4-ES-0074, *Monitoring Well Inspection and Maintenance* (1/3/2018)	Contractor	Sampling	N	N/A
12	CP4-ES-2700, *Logbooks and Data Forms* (12/7/2017)	Contractor	N/A	N	N/A
13	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (1/4/2018)	Contractor	Sampling	N	N/A

QAPP Worksheet #21. (Continued)
Project Sampling SOP References Table

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
14	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/2/2018)[b]	Contractor	N/A	N	N/A
15	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* (12/12/2017)	Contractor	N/A	N	N/A
16	CP3-ES-5003, *Quality Assured Data* (1/9/2018)	Contractor	N/A	N	N/A
17	CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling* (6/25/2018)	Contractor	N/A	N	N/A
18	CP4-ES-5007, *Data Management Coordination* (4/25/2019)	Contractor	N/A	N	N/A
19	CP2-ES-5102, *Radiochemical Analysis Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
20	CP2-ES-5103, *Polychlorinated Dibenzodioxins/Polychlorinated Dibenzofurans Analyses Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
21	CP2-ES-5105, *Volatile and Semivolatile Analyses Data Verification and Validation* (9/27/2018)	Contractor	N/A	N	N/A
22	CP2-ES-5107, *Inorganic Analyses Data Validation and Verification* (12/13/2017)	Contractor	N/A	N	N/A
23	CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans* (12/27/2017)	Contractor	N/A	N	N/A
24	CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases* (12/21/2017)	Contractor	N/A	N	N/A

[a] SOPs are posted to the FRNP intranet website. External FFA parties can access this site using remote access with privileges upon approval. It is understood that SOPs are contractor specific.
[b] The work will be conducted by FRNP staff or a subcontractor. In either case, the most current version of the SOPs listed will be followed.
N/A = not applicable
[c] The Hazardous Waste Management Facility Permit defines a duplicate as being collected from a single sample collection container or sample mixing container. This SOP defines a duplicate as being collected using the same procedural requirements as the original sample. Duplicates collected from MWs at the C-404 Landfill under the permit will be collected as prescribed in the permit and as prescribed in this SOP.

QAPP Worksheet #22.
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

The following is the field equipment to be used on the project.

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Water Quality Meter (permit application of the landfills specify Hydrolab)	Calibrate at the beginning of the day	Performed monthly and as needed	Measure solutions with known values (National Institute for Standards and Technology traceable buffers and conductivity calibration solutions)	Upon receipt, successful operation	Daily before each use	Per manufacturer's specifications	Recalibrate or service as necessary	Field Team Leader	Manufacturer's specifications
Turbidity Meter (Nephthelometer)	Calibrate daily before each use	As needed	Measure solutions with known turbidity standards	Upon receipt, successful operation	Daily before each use	N/A (instrument zeroed)	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Ferrous Iron Colorimeter	Accuracy check at the beginning of each day	Return to instrument rental for replacement	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's specifications
Colorimeter (for total residual chlorine)	Accuracy check at the beginning of each day	As needed	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Within range of manufacturer's standard	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Titrator (for total residual chlorine)	Calibrate to manufacturer's solution weekly	As needed	Measure with standard solution	Upon receipt, successful operation	Weekly	With range of manufacturer's standard	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Electron Water Level Meter	N/A	None	Check daily before each use	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's specifications
Hach® flow meter	Calibrate to readings on flume	Quarterly or as needed	Measure against flume	Upon receipt, successful operation	Weekly as needed	Pass/Fail	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Colloidal Borescope	N/A	Clean as needed	Ensure aligned with magnetic north	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications

QAPP Worksheet #22.
Field Equipment Calibration, Maintenance, Testing, and Inspection Table (Continued)

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Magnetic Hand-Held Compass	N/A	None	None	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Pressure Transducer (Data Logger typically used for water level measurement in monitoring wells)	Return to manufacturer annually for calibration	Return to manufacturer for maintenance, as needed	Compare water level reading against reading from electron water level meter	Upon receipt, successful operation	Before each use, as needed	Per manufacturer's specifications	Return to manufacturer for repair or replacement	Field Team Leader	CP4-ES-2100, *Groundwater Level Measurement*/ Manufacturer's specifications

*Additional equipment may be needed; additional equipment will follow manufacturer's specifications for calibration, maintenance, inspection, and testing. Calibration data will be documented in logbooks consistent with CP4-ES-2700, *Logbooks and Data Forms*.
N/A = not applicable

QAPP Worksheet #23.
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/Matrix	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
8260/624.1	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	VOA (Unless noted below)/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
8270	SVOCs by GC/MS	Definitive	SVOCs/Water	Per SOP	GEL Laboratories, Charleston, SC	N
8011	1,2-Dibromoethane and 1,2-Dibromo-3-Chloropropane by Microextraction and Gas Chromatography	Definitive	VOA (1,2-Dibromo-3-chloropropane)/ Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
9056/300.0	Determination of Inorganic Anions by Ion Chromatography	Definitive	Anions/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
N/A	RSK175	Definitive	VOA (Ethene, Ethane, Methane)/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
410.4	Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry	Definitive	Miscellaneous (Chemical Oxygen Demand)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
350.1	Determination of Ammonia Nitrogen by Semi-Automated Colorimetry	Definitive	Miscellaneous (Ammonia as Nitrogen)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
9010/ 9012B	Total and Amenable Cyanide	Definitive	Miscellaneous (Cyanide)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
9040	pH Electrometric Measurement	Definitive	Miscellaneous (pH—when not as field measurement)/ Water	pH Meter	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/Matrix	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SM 5210 B	Standard Method for Biochemical Oxygen Demand	Definitive	Miscellaneous (Carbonaceous Biological Oxygen Demand)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
180.1	Determination of Turbidity by Nephelometry	Definitive	Miscellaneous (Turbidity—when not as field measurement)/ Water	Per SOP	GEL Laboratories, Charleston, SC	N
130.2/SM 2340 C	Hardness	Definitive	Miscellaneous (Hardness)/ Water	Per SOP	GEL Laboratories, Charleston, SC	N
9060	Total Organic Carbon	Definitive	Miscellaneous [Total Organic Carbon (TOC)]/Water	Per SOP	GEL Laboratories, Charleston, SC	N
160.1	Total Dissolved Solids	Definitive	Miscellaneous (Total Dissolved Solids)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
160.2/ SM 2540 D	Total Suspended Solids	Definitive	Miscellaneous (Total Suspended Solids)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
SM 2540 B	Solids in Water	Definitive	Miscellaneous (Total Solids)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
365.4	Phosphorous, Total	Definitive	Miscellaneous (Total Phosphorous)/ Water	Per SOP	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/Matrix	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
9020	Total Organic Halides (TOX)	Definitive	Miscellaneous (Total Organic Halides)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
200.7	Trace Elements in Water, Solids, and Biosolids by Inductively Coupled Plasma-Atomic Emission Spectrometry	Definitive	Miscellaneous (Silica)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
310.1	Alkalinity	Definitive	Miscellaneous (Alkalinity)/ Water	Per SOP	GEL Laboratories, Charleston, SC	N
1664A	Determination of Oil and Grease and Total Petroleum Hydrocarbons in Waste Water	Definitive	Miscellaneous (Oil and Grease)/Water	Per SOP	GEL Laboratories, Charleston, SC	N
6020/200.8 /ICP-MS	Inductively Coupled Plasma-Mass Spectrometry	Definitive	Metals (Unless noted below)/Soil and Water, Radionuclides (Uranium-234, Uranium-235, Uranium-238)/ Water	Per SOP	GEL Laboratories, Charleston, SC	N
7470/7471	Cold Vapor Atomic Absorption	Definitive	Metals (Mercury)/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/Matrix	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
8082/608.3	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	Definitive	PCBs/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
9310/900.0	Gross Alpha and Gross Beta	Definitive	Radionuclides/ Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
906.0	Tritium in Drinking Water	Definitive	Radionuclides/ Water	Per SOP	GEL Laboratories, Charleston, SC	N
Gamma Spec**	Gamma Spectrometry	Definitive	Radionuclides (Cesium-137)/ Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
Gas Flow Proportional**	Gas Flow Proportional	Definitive	Radionuclides (Strontium-90)/ Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
Liquid Scintillation**	Tc-99 by Liquid Scintillation	Definitive	Radionuclides/ Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N
Alpha Spec**	Alpha Spectrometry	Definitive	Radionuclides (Americium-241, Thorium-230, Uranium-234, Uranium-235, Uranium-238, Neptunium-237, Plutonium-238, Plutonium-239/ 240)/Soil and Water	Per SOP	GEL Laboratories, Charleston, SC	N

*Information will be based on laboratory used. Analysis will be by the most recent revision.
**Analytical methods for radiochemistry parameters are laboratory specific.
NDIRD = nondispersive infrared detector
ICP-MS = inductively coupled plasma mass spectrometer

QAPP Worksheet #24.
Analytical Instrument Calibration Information

Laboratories used by FRNP are participants in DOECAP. In the fall of 2017, DOECAP began providing certification of environmental laboratories through third party organizations. If not in DOECAP, laboratories are audited by contractors for compliance with DOECAP program requirements. As such, laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program as summarized in the SOPs. The laboratory is responsible for maintaining instrument calibration information per their QA Plan including control charts established for all instrumentation.

Whenever possible, the laboratory uses recognized procedures for calibration such as those published by EPA or American Society for Testing and Materials. If established procedures are not available, the laboratory develops a calibration procedure based on the type of equipment, stability, characteristics of the equipment, required accuracy, and the effect of operation error on the quantities measured. Whenever possible, physical reference standards associated with periodic calibrations, such as weights or certified thermometers with known relationships to nationally recognized standards are used. Where national reference standards are not available, the basis for the reference standard is documented. Equipment or instruments that fail calibration or become inoperable during use are tagged to indicate they are out of calibration. Such instruments or equipment are repaired and successfully recalibrated prior to reuse. High resolution mass spectrometer instruments undergo extensive tuning and calibration prior to running each sample set. The calibrations and ongoing instrument performance parameters are recorded and reported as part of the analytical data package.

QAPP Worksheet #25.
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
GC-MS	Replace/clean ion source; clean injector, replace injector liner, replace/clip capillary column, flush/replace tubing on purge and trap; replace trap	QC standards	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
GC	ECD maintenance; replace/clip capillary column	QC standards	ECD, FID, injector, injector liner, column, column flow	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
ICP-MS and ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	QC standards	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23
pH meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
Spectrophotometer	Flush/replace tubing	QC standards	Tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity of remove from service	Laboratory Manager	See Worksheet #23
TOC Analyzer (NDIRD)	Replace sample tubing, clean sample boat, replace syringe	QC standards	Tubing, sample boat, syringe	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
CVAA	Replace tubing, check instrument lines and connections, check windows in cell, ensure lamp is operational	QC standards	Instrument lines and connections, windows, and lamp	As needed	Must meet initial and/or continuing calibrations criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23

*The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited. Laboratory(s) contracted will participate in DOECAP, with the exception of the laboratory used to support acute and chronic toxicity analysis in support of the KPDES permit. This laboratory is a KPDES Wastewater Laboratory certified by the Commonwealth of Kentucky and provides the required information to FRNP to be included on the approved suppliers list. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

CVAA = cold vapor atomic absorption; ECD = electron capture detector; FID = flame ionization detector; GC = gas chromatography; GC-MS = gas chromatography- mass spectrometer; ICP-AES = inductively coupled plasma atomic; emission spectroscopy; ICP-MS = inductively coupled plasma mass spectrometer; NDIRD = nondispersive infrared detector; QC = quality control; TOC = total organic carbon

QAPP Worksheet #26 and 27.
Sample Handling, Custody, and Disposal

Sampling Organization: Sampling Teams/DOE Prime Contractor and Subcontractors

Laboratory: See Worksheets #19 and #30

Method of sample delivery (shipper/carrier): Direct Delivery or Overnight/Federal Express or UPS in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.

Number of day from reporting until sample disposal: 3 months

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Chain of custody form completion	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Packaging	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Shipping coordination	Sample Management Office /DOE Prime Contractor	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Sample receipt, inspection, & log-in	Sample Management/Contracted Laboratory	Contracted Laboratory SOP
Sample custody and storage	Sample Management/Contracted Laboratory	Contracted Laboratory SOP
Sample disposal	Sample Management/Contracted Laboratory	Contracted Laboratory SOP

QAPP Worksheet #28.
QC Samples Table (Aqueous)

Matrix: Aqueous Samples
Analytical Group/Concentration Level: VOCs, Metals, PCBs, RADs, SVOCs
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: GEO Consultants
Analytical Organization: GEL Laboratories
No. of Sample Locations: See Appendix C of the EMP

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze	Laboratory should alert project	Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples (MS and/or MSD)	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks (LCS)	1 per analytical batch	See data validation plans CP2-ES-5105, -5107	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*

QAPP Worksheet #28. (Continued)
QC Samples Table (Aqueous)

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate standards	All samples, blanks, and QA (or QC) samples	See data validation plans CP2-ES-0811, -5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All samples and standards	See data validation plan CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate***	Minimum 5%	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% sediment, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Tracers/Carriers	Each sample tested by a radiochemical separation method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*

*The number of QC samples is listed on Worksheet #20.
**Unless dictated by project-specific parameters, ≤ contract-required quantitation limit (CRQL).
***The Hazardous Waste Management Facility Permit defines a duplicate as being collected from a single sample collection container or sample mixing container. CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation*, defines a duplicate as being collected using the same procedural requirements as the original sample. Duplicates collected from MWs at the C-404 Landfill under the permit will be collected as prescribed in the permit and as prescribed in the SOP.

QAPP Worksheet #28.
QC Samples Table (Sediment)

Matrix: Sediments
Analytical Group/Concentration Level: VOCs, Metals, PCBs, Radionuclides,
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: GEO Consultants
Analytical Organization: GEL Laboratories
No. of Sample Locations: See Appendix C of the EMP

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze	Laboratory should alert project	Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples (MS and/or MSD)	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks (LCS)	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

QAPP Worksheet #28-B. (Continued)
QC Samples Table (Sediment)

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate Standards	All samples, blanks, and QA (or QC) samples	See data validation plans CP2-ES-0811, -5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All sample blanks and QA samples	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous, Specific RPD defined for each group in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Tracers/Carriers	Each sample tested by a radiochemical separations method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples	Laboratory analyst	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*

*The number of QC samples is listed on Worksheet #20.
**Unless dictated by project-specific parameters, ≤ CRQL.

QAPP Worksheet #29.
Project Documents and Records Table

This worksheet describes how information will be collected, verified, and stored. Its purpose is to support data completeness, data integrity, and ease of retrieval.

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Field Logbook or Data Sheets	Field Team	Field Team Leader	Project File
Chain-of –Custody Forms	Field Team	Field Team Leader	Project File
Air Bills	Contract Laboratory	Contract Laboratory	Project File
Equipment Calibration Forms	Field Team	Field Team Leader	Project File
Deviations	Project Manager	Project Director	Project File
Corrective Action Reports	Project Manager	Project Director	Project File
Correspondence	Project Manager	Project Director	Project File

Project Assessments			
Record	**Generation**	**Verification**	**Storage location/archival**
Field Audit Checklists	Project Manager	Project Director	Project File
Data Verification Checklists	Sample Management Office/ Data Validator	Sample Management Office	Project File
Data Validation Report	Data Validator	Sample Management Office	Project File
Data Usability Assessment Report	Data Validator	Sample Management Office	Project File

Laboratory Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Level IV Laboratory Reports	Laboratory Staff	Laboratory Project Manager	Project File
Electronic Data Deliverables	Laboratory Staff	Laboratory Project Manager	Project File

QAPP Worksheets #31, 32, and 33.
Assessments and Corrective Action

This worksheet is used to document responsibilities for conducting project assessments, responding to assessment findings and implementing corrective action. Appropriately scheduled assessments (e.g., field sampling technical systems audits at the beginning of sampling) allow management to implement corrective action in a timely manner, thereby correcting nonconformances and minimizing their impact on DQOs/PQOs. Assessment checklists should be included in the QAPP or referenced.

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Date	Assessment Deliverable	Deliverable Due Date
Field Sampling	Field Team Leader/ FRNP	Quarterly	TBD	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Repot	Per Individual Laboratory QA Manual
Management Review	Project Director/ FRNP	Interim management review following site mobilization; final management review upon completion of fieldwork	Annually	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*

TBD = to be determined

QAPP Worksheets #31, 32, and 33. (Continued)
Assessments and Corrective Action

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Time Frame for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Field Sampling	Field Team Leader/FRNP	Field Sampling Corrective Action Response	24 hours from receipt of memorandum	Field Team Leader/FRNP	Contractor Performance Assurance Program (CPAP) Manager/FRNP
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Internal Audit Report Deficiency Memorandum	7 days following receipt of proficiency testing deficiency report and before analysis field samples	Laboratory Technical Director	QA Manager/FRNP
Management Review	Project Director/ FRNP	Management Response	As described in CP3-QA-1003, *Management and Self-Assessment*	As assigned in Management Response	CPAP Manager/FRNP

QAPP Worksheet #34.
Data Verification and Validation Inputs

This worksheet is used to list the inputs that will be used during data verification and validation. Data verification is a check that specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs, and the QAPP. Records subject to verification and validation are listed below.

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	X
2	Contract	X	X
3	Field SOPs	X	X
4	Laboratory SOPs	X	X
Field Records			
5	Field Logbooks and/or sample data forms	X	X
6	Equipment calibration records	X	X
7	Chain-of-Custody forms	X	X
8	Sampling diagrams/surveys	X	X
9	Drilling logs	X	X
10	Geophysics reports	X	X
11	Relevant correspondence	X	X
12	Change orders/deviations	X	X
13	Field audit reports	X	X
14	Field corrective action reports	X	X

QAPP Worksheet #34. (Continued)
Data Verification and Validation Inputs

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	X	X
16	Case narrative	X	X
17	Internal laboratory chain-of-custody	X	X
18	Sample receipt records	X	X
19	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
20	Communication records	X	X
21	Project-specific proficiency testing sample results	X	X
22	Limit of detection/limit of quantification establishment and verification	X	X
23	Standards Traceability	X	X
24	Instrument calibration records	X	X
25	Definition of laboratory qualifiers	X	X
26	Results reporting forms	X	X
27	QC sample results	X	X
28	Corrective action reports	X	X
29	Raw data	X	X
30	Electronic data deliverable	X	X

QAPP Worksheet #35.
Data Verification Procedures

This worksheet documents procedures that will be used to verify project data. Data verification is a completeness check to confirm that required activities were conducted, specified records are present, and the contents of the records are complete.

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Field logbook and/or sample data forms	QAPP, Field SOPs	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented.	Field Team Leader/FRNP—Performs daily review Sample Management Office/FRNP—Performs review as part of data verification and data assessment
Chain-of-custody forms	QAPP, Field SOPs	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook/data form. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Field Team Leader/FRNP—Performs daily review Sample Management Office/FRNP—Performs review as part of data verification and data assessment Data Validator/Veolia Nuclear Solutions Federal Services—Performs review as part of data validation

QAPP Worksheet #35. (Continued)
Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Laboratory deliverables	QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the COCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Laboratory PM/Contract Laboratory—Performs review before data is released Sample Management Office/FRNP—Performs review part of data verification and data assessment Data Validator/ Veolia Nuclear Solutions Federal Services—Performs review as part of data validation
Audit reports, corrective action reports	QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	CPAP Manager/FRNP

QAPP Worksheet #36.
Data Validation Procedures

Data Validator: Veolia Nuclear Solutions Federal Services

Data validation plans are listed in Worksheet #21. These plans also are available on the FRNP ftp site. The fixed-base laboratory will provide data in an Electronic Data Deliverable (EDD). Groundwater data from the quarterly sampling events at the C-746-U and C-746-S&T Landfills and the semiannual sampling events at the C-404 Landfill will be validated. The groundwater data to be validated was chosen because groundwater comprises the majority of the media collected by the Environmental Monitoring Program. Additionally, the landfill requirements encompass the majority of all types of analyses specified within the Environmental Monitoring Program. Therefore, these programs are considered an adequate representation of Environmental Monitoring data targeted for data validation.

QAPP Worksheet #37.
Data Usability Assessment

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and, like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Environmental Monitoring Project Manager
Risk Assessor
Data Validator
Sample Management Office
Field Team Leader

Describe how the usability assessment will be documented:

Data usability will be documented through validation reports as well as through the data assessment review checklist and comment form included in the data assessment packages. Data assessment packages will be created, which will include data assessment comments/questions and laboratory comments. Data verification and assessment queries indicating any historical outliers will be included in the data assessment packages.

FRNP shall determine the adequacy of data based on the results of validation and verification. The usability step involves assessing whether the process execution and resulting data meet project quality objectives documented in the QAPP.

Field and analytical data are verified and assessed per procedure CP3-ES-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. Data assessment packages will include field and analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to

QAPP Worksheet #37. (Continued)
Data Usability Assessment

document any issues pertaining to the data and to indicate if data quality objectives of the project were met. For data selected for validation, the following plans are used: CP2-ES-0026, CP2-ES-0811, CP2-ES-5102, CP2-ES-5105, and CP2-ES-5107.

PARCCS parameters (precision, accuracy, representativeness, comparability, completeness, and sensitivity) will be evaluated per procedure CP3-ES-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

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