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RECEIVED
By Jennifer.Howle at 6:45 am, Nov 04, 2021

November 3, 2021

Mr. Brian Begley
Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

PPPO-02-10017070-22B

Ms. Victor Weeks
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Mr. Weeks:

TRANSMITTAL OF THE REMEDIAL ACTION WORK PLAN FOR SWMU 211-A ENHANCED *IN SITU* BIOREMEDIATION FOR VOLATILE ORGANIC COMPOUND SOURCES TO THE SOUTHWEST GROUNDWATER PLUME AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-2443&D2/R1

References:

1. *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency Conditional Concurrence on the Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2443&D2*, dated September 7, 2021
2. Letter from B. Begley to T. Duncan, "RE: Kentucky Concurrence to the Remedial Action Work Plan for SWMU 211-A Enhanced *In Situ* Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume (DOE/LX/07-2443&D2), Paducah Site, Paducah, McCracken County, Kentucky, #KY8-890-008-982," dated May 27, 2020
3. Letter from V. Weeks to T. Duncan, "RE: U.S. Environmental Protection Agency Conditions for Approval of the Remedial Action Work Plan for SWMU 211-A Enhanced *In Situ* Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2443&D2), transmittal date of March 30, 2020," dated May 26, 2020

Enclosed for approval is the certified *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2/R1, (RAWP). Enclosed are a certification page, a clean version of the RAWP, a redline version of

the RAWP, a comment response summary (CRS) for U.S. Environmental Protection Agency (EPA) undisputed conditions, and a summary of other changes.

This D2/R1 version of the RAWP addresses EPA conditions (Reference 3) and is consistent with the terms of the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency Conditional Concurrence on the Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky, DOE/LX/07-2443&D2* (MOA) (Reference 1).

The Kentucky Department for Environmental Protection (KDEP) issued a letter of concurrence on the D2 RAWP on May 27, 2020 (Reference 2).

Please note that when addressing EPA conditions, worksheets associated with the Quality Assurance Project Plan were updated as a result of organizational changes and document revisions. The updates to the worksheets were not in response to a condition or comment. Details associated with these changes are included in the Other Changes Summary.

The U.S. Department of Energy (DOE) appreciates EPA's and KDEP's efforts in assisting with the finalization of the RAWP. Consistent with the terms of the MOA, DOE requests EPA and KDEP approval of the D2/R1 RAWP within 30 days of receipt of this letter. DOE looks forward to EPA and KDEP approval of the D2/R1 RAWP and the upcoming initiation of SWMU 211-A field work.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Tracey L. Duncan

Digitally signed by Tracey L. Duncan
Date: 2021.11.03 16:34:31 -05'00'

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:

1. Certification Page
2. *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2/R1—Clean
3. *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2/R1—Redline
4. EPA CRS for Undisputed Conditions
5. Other Changes Summary

Administrative Record File—SWP-PD

cc w/enclosures:
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CERTIFICATION

Document Identification: *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2/R1, dated November 2021

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Four Rivers Nuclear Partnership, LLC

Myrna E. Redfield, Program Manager
Four Rivers Nuclear Partnership, LLC

11/3/21
Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

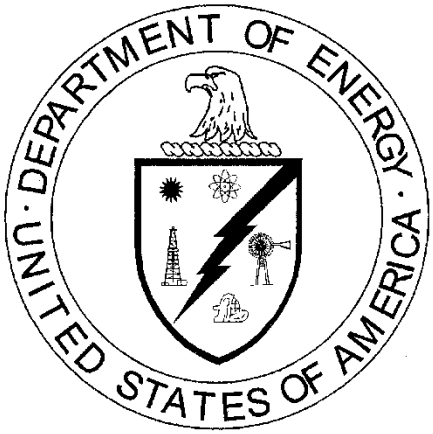
U.S. Department of Energy

Jennifer Woodard, Paducah Site Lead
Portsmouth/Paducah Project Office
U.S. Department of Energy

11/3/21
Date Signed

DOE/LX/07-2443&D2/R1
Primary Document

Remedial Action Work Plan for SWMU 211-A Enhanced *In Situ* Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky



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DOE/LX/07-2443&D2/R1
Primary Document

Remedial Action Work Plan for SWMU 211-A Enhanced *In Situ* Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—November 2021

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

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ACRONYMS

AAD	annual average discharge
ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
CAAS	criticality accident alarm system
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	certified for construction
CFR	*Code of Federal Regulations*
COC	contaminant or radionuclide of concern
CRZ	contamination reduction zone
CSA	CERCLA staging area
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DHC	*Dehalococcoides ethenogenes*
DMIP	data management implementation plan
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DPT	direct push technology
EDD	electronic data deliverable
EISB	enhanced *in situ* bioremediation
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ER	environmental remediation
EVO	emulsified vegetable oil
EVS	Environmental Visualization Systems
EZ	exclusion zone
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
GIS	geographic information system
GPS	Global Positioning System
HAP	hazardous air pollutant
HASP	health and safety plan
HAZWOPER	Hazardous Waste Site Operations and Emergency Response
HSS&Q	health, safety, support, and quality
HU	hydrogeologic unit
IH	industrial hygiene
IS	industrial safety
ISMS	Integrated Safety Management System
JHA	job hazard analysis
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LCD	Lower Continental Deposits
LDR	land disposal restriction
LLW	low-level waste

LOTO	lockout/tagout
LUC	land use control
MCL	maximum contaminant level
MW	monitoring well
NCS	nuclear criticality safety
NWS	National Weather Service
OREIS	Oak Ridge Environmental Information System
OSHA	Occupational Safety and Health Administration
OU	operable unit
PA	public address
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PEL	permissible exposure limit
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
PPPO	Portsmouth/Paducah Project Office
PSS	plant shift superintendent
PTW	principal threat waste
PWMC	project waste management coordinator
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RA	remedial action
RACR	remedial action completion report
RAD	radiological
RADCON	radiological control
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RDR	remedial design report
RDSI	remedial design support investigation
RFD	request for disposal
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	record of decision
RPP	Radiation Protection Program
RTL	ready to load
RWP	radiological work permit
SI	site investigation
SMO	Sample Management Office
SMP	Site Management Plan
SOW	statement of work
SWMU	solid waste management unit
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TLV	threshold limit value
TRU	transuranic
TSCA	Toxic Substance Control Act
UCD	Upper Continental Deposits
UCRS	Upper Continental Recharge System

UIC	Underground Injection Control
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WICL	waste item container log
WMP	waste management plan
ZVI	zero-valent iron

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EXECUTIVE SUMMARY

This remedial action (RA) project was selected in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0365&D2/R1 (ROD) (DOE 2012). This RA satisfies, for volatile organic compound (VOC) contamination in the Upper Continental Recharge System (UCRS) soils, the mandates of the Comprehensive Environmental Response, Compensation, and Liability Act and the National Contingency Plan to be protective of human health and the environment by addressing VOC contamination through active treatment and through interim land use controls (LUCs) for any residual VOC and non-VOC contamination. The action will contribute to the final remediation of the Groundwater Operable Unit by removing contaminant trichloroethene mass (TCE) and other VOCs at Solid Waste Management Unit (SWMU) SWMU 211-A through treatment and will achieve applicable or relevant and appropriate requirements for the action (DOE 2012). As documented in the ROD, enhanced *in situ* bioremediation (EISB) is expected to remove approximately 95% of the contaminant mass, and the remaining mass is estimated to attenuate within approximately 39 years. The total expected TCE volume, based on data from the Remedial Design Support Investigation performed in 2012 and analyzed in development of the *Addendum to the Final Characterization Report for the Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1/R1, has been estimated to be up to 2.2 gal (DOE 2016).

The RA includes the design, installation, and monitoring of EISB with interim LUCs. EISB will be performed on UCRS soils. The bioremediation will utilize emulsified vegetable oil and will include bioaugmentation. To assist in more uniform placement of the bioamendments in the UCRS soils, fracturing of the soil will be performed. The fractures will be filled with proppant composed of sand and zero-valent iron. The completed design of the RA is contained in *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2435&D2 (DOE 2019a).

This remedial action work plan (RAWP) provides project background information, remedial action objectives, implementation approach and the area to be treated, the project organization, and a project planning schedule. In addition, this RAWP addresses waste management and disposition, project health and safety, quality assurance and data management, and environmental compliance associated with implementing the project.

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1. INTRODUCTION

This *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D1, (RAWP) has been prepared for source treatment using enhanced *in situ* bioremediation (EISB) with interim land use controls (LUCs) for Solid Waste Management Unit (SWMU) 211-A. The remedy planned for the SWMU 211-A is documented in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0365&D2/R1 (DOE 2012) (ROD). The ROD specified that the remedy to be implemented for SWMU 211-A Upper Continental Recharge System (UCRS) soils would be either EISB with interim LUCs and groundwater sampling or long-term monitoring with interim LUCs. Final selection was made by the Federal Facility Agreement (FFA) parties following performance of the final characterization that was part of the Remedial Design Support Investigation (RDSI) in 2012–2013; performance of additional groundwater characterization in July 2015; issuance of an Addendum to the Final Characterization Report (DOE 2016); and Letter Notification identifying the U.S. Department of Energy (DOE) chosen remedy based on foregoing studies in December 2015 (DOE 2015a). The remedial action (RA) project to be implemented at SWMU 211-A is EISB with interim LUCs and groundwater sampling, and the RA was arrived at during the final RAs discussed in the May 23, 2018, presentation to the FFA parties. The May 23, 2018, presentation can be reviewed at the Paducah Gaseous Diffusion Plant (PGDP) Environmental Information Center at Accession Number ENV 1.A-01526 in the Search category (DOE 2018).

In August 2017, the FFA parties signed the *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, that agreed that all projects (except C-400 and Southwest Plume SWMU 211-A) would be resequenced in the fiscal year 2018 Site Management Plan (SMP) (DOE 2017a). As a result of that agreement, the planned remedial activity for SWMU 211-B will not be included in this RAWP. Future activities associated with SWMU 211-B will be reevaluated and resequenced as part of the PGDP SMP process(es).

The interim LUCs for all three SWMUs that were included in the signed ROD are in place and operating. The LUCs associated with SWMU 211-B will remain in place pending SWMU 211-B future activities as determined in SMP development. The interim LUCs consist of the excavation/penetration permit program and warning signs. The interim LUCs for SWMU 211-A will remain in place pending final remedy selection as part of a subsequent operable unit (OU) that addresses the relevant media.

An associated remedial design report (RDR) has been developed, and it will be used along with this approved RAWP to implement the selected RA at SWMU 211-A (DOE 2019a).

PGDP is located approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County. PGDP is an inactive uranium enrichment facility owned by DOE that currently is undergoing deactivation and remediation (Figure 1). Bordering PGDP to the northeast, between the PGDP plant and the Ohio River, is the Tennessee Valley Authority Shawnee Fossil Plant. The remaining Paducah Site border is shared with the West Kentucky Wildlife Management Area. Before PGDP was constructed, a munitions production facility, the Kentucky Ordnance Works, was operated at the current PGDP location and at an adjoining area southwest of the site. Munitions, including trinitrotoluene, were manufactured and stored at Kentucky Ordnance Works between 1942 and 1945. Construction of PGDP was initiated in 1951, and the plant began operation in 1952. PGDP construction was completed in 1955, and PGDP became fully operational in that year, supplying enriched uranium for commercial reactors and military defense reactors. Uranium enrichment operations ceased at PGDP in 2013.

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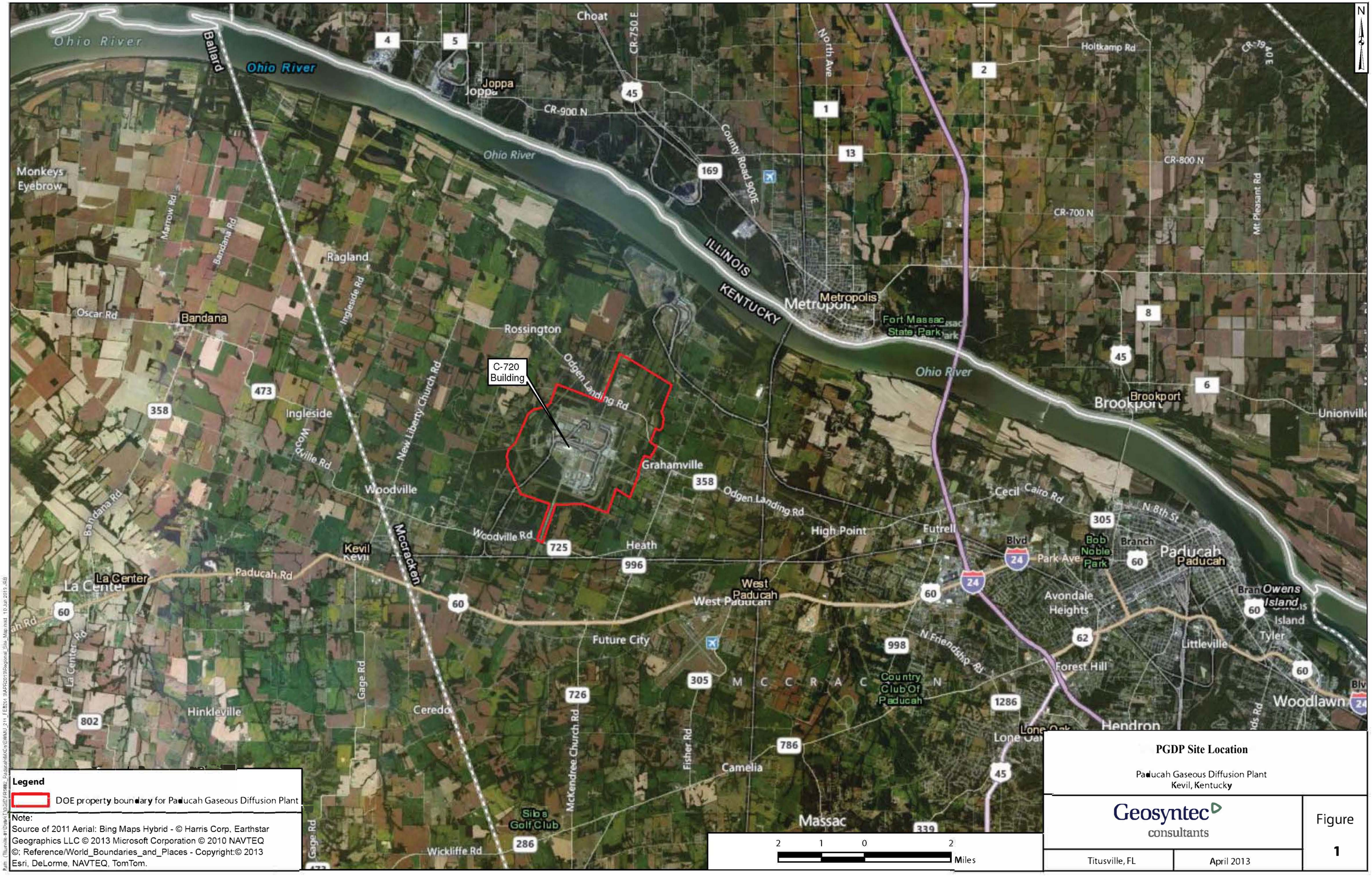

Legend

DOE property boundary for Paducah Gaseous Diffusion Plant

Note:
Source of 2011 Aerial: Bing Maps Hybrid - © Harris Corp, Earthstar Geographics LLC © 2013 Microsoft Corporation © 2010 NAVTEQ ©; Reference/World_Boundaries_and_Places - Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom.

PGDP Site Location

Paducah Gaseous Diffusion Plant
Kevil, Kentucky

Geosyntec consultants

Titusville, FL | April 2013

Figure 1

Figure 1. PGDP Site Location

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The Southwest Groundwater Plume refers to an area of groundwater contamination at the Paducah Site in the Regional Gravel Aquifer (RGA), which is south of the Northwest Groundwater Plume and west of the C-400 Cleaning Building (also known as the C-400 Building). The plume was identified during the Waste Area Grouping (WAG) 27 Remedial Investigation (RI) in 1998 (DOE 1999). Additional work to characterize the plume was performed as part of the WAG 3 RI (DOE 2000a), Data Gaps Investigation (DOE 2000b), and the RDSI (DOE 2016). As discussed in these reports, the primary groundwater contaminant of concern (COC) for the Southwest Groundwater Plume (referred to as the Southwest Plume) is trichloroethene (TCE). Other contaminants found in the plume include additional volatile organic compounds (VOCs), metals, and the radionuclide, technetium-99 (Tc-99).

DOE conducted a site investigation (SI) in 2004 to address uncertainties associated with potential source areas to the Southwest Plume that remained after previous investigations. The SI further profiled the concentration and distribution of VOCs in the dissolved-phase plume along the west plant boundary at that time. Results of the SI were reported in the *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2/R1 (DOE 2007). The *Revised Focused Feasibility Study for Solid Waste Management Units 1, 211-A, and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0362&D2, (DOE 2011) is based on the SI (DOE 2007) and previous investigations. The ROD for this action was signed in 2012. An RDSI was performed in 2012 consistent with the Remedial Design Work Plan (DOE 2015b). Additional characterization of SWMU 211-A also was performed in 2015 before the FFA parties decided to proceed with implementing the RA.

1.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

1.1.1 Regional Geology

Regional Geology. The Paducah Site is located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. See Figure 2, which is a generalized lithostratigraphic column for the PGDP area.

Mississippian carbonates form the nearest outcrop of bedrock and are exposed approximately 9 miles northwest of PGDP in southern Illinois (MMES 1992). Coastal Plain deposits unconformably overlie Mississippian carbonate bedrock and consist of the following: the Tuscaloosa Formation; sand and clays of the Clayton/McNairy Formations; the Porters Creek Clay; and Eocene Sands and clay deposits (undivided Jackson, Claiborne, and Wilcox Formations). Continental Deposits unconformably overlie the Coastal Plain deposits, which are, in turn, covered by loess and/or alluvium.

Relative to the shallow groundwater flow system in the vicinity of the Paducah Site, the Continental Deposits and the overlying loess and alluvium are of key importance. The Continental Deposits resemble a large, low-gradient alluvial fan that covered much of the region and eventually buried the erosional topography. A principal geologic feature in the Paducah Site area is the Porters Creek Clay Terrace slope, a subsurface terrace that trends approximately east to west across the southern portion of the plant. The Porters Creek Clay Terrace slope represents the southern limit of erosion or scouring of the ancestral Tennessee River. Thicker sequences of Continental Deposits, as found underlying the Paducah Site, represent valley fill deposits and can be divided informally into a lower unit (gravel facies) and an upper unit (clay facies). The Lower Continental Deposits (LCD) are the gravel facies consisting of chert gravel in

SYSTEM	SERIES	FORMATION	THICKNESS (IN FEET)	DESCRIPTION	HYDROGEOLOGIC SYSTEMS
QUATERNARY	PLEISTOCENE AND RECENT	ALLUVIUM	0-40	Brown or gray sand and silty clay or clayey silt with streaks of sand.	Upper Continental Recharge System
	PLEISTOCENE	LOESS	0-43	Brown or yellowish-brown to tan unstratified silty clay.	
	PLEISTOCENE	CONTINENTAL DEPOSITS	3-121	Upper Continental Deposits (Clay Facies) - mottled gray and yellowish brown to brown clayey silt and silty clay, some very fine sand, trace of gravel. Often micaceous.	
TERTIARY	PLIOCENE-MIOCENE (?)			Lower Continental Deposits (Gravel Facies) - reddish-brown clayey, silty and sandy chert gravel and beds of gray sand.	Regional Gravel Aquifer
	EOCENE	JACKSON, CLAIBORNE, AND WILCOX FORMATIONS	0-200+	Red, brown or white fine to coarse grained sand. Beds of white to dark gray clay are distributed at random.	McNairy Flow System
			0-100+	White to gray sandy clay, clay conglomerates and boulders, scattered clay lenses and lenses of coarse red sand. Black to dark gray lignitic clay, silt or fine grained sand.	
	PALEOCENE	PORTERS CREEK CLAY	0-200	Dark gray, slightly to very micaceous clay. Fine grained clayey sand, commonly glauconitic in the upper part. Glauconitic sand and clay at the base.	
		CLAYTON FORMATION	Undetermined	Lithologically similar to underlying McNairy Formation.	
UPPER CRETACEOUS		McNAIRY FORMATION	200-300	Grayish-white to dark gray micaceous clay, often silty, interbedded with light gray to yellowish-brown very fine to medium grained sand with lignite and pyrite. The upper part is interbedded clay and sand, and the lower part is sand.	
		TUSCALOOSA FORMATION	Undetermined	White, well rounded or broken chert gravel with clay.	
MISSISSIPPIAN		MISSISSIPPIAN CARBONATES	500+	Dark gray limestone and interbedded chert, some shale.	

Adapted from Olive 1980.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 2. Generalized Lithostratigraphic Column for the PGDP Region

Figure 2. Generalized Lithostratigraphic Column for the PGDP Region

a matrix of poorly sorted sand and silt that rests on an erosional surface representing the beginning of the valley fill sequence. In total, the gravel unit averages approximately 30-ft thick, but some thicker deposits (as much as 50 ft) exist in deeper scour channels. The Upper Continental Deposits (UCD) primarily is a sequence of fine grained, clastic facies varying in thickness from 15 ft to 60 ft that consists of clayey silts with lenses of sand and occasional gravel.

The area of the Southwest Plume lies within the buried valley of the ancestral Tennessee River in which Pleistocene Continental Deposits (the fill deposits of the ancestral Tennessee River Basin) rest unconformably on Cretaceous marine sediments. Pliocene through Paleocene formations in the area of the Southwest Plume have been removed by erosion of the ancestral Tennessee River Basin. In the area of the Southwest Plume and its sources, the upper McNairy Formation consists of 60 ft to 70 ft of interbedded units of silt and fine sand and underlies the Continental Deposits. Total thickness of the McNairy Formation is approximately 225 ft.

The surface deposits found in the vicinity of the Paducah Site consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

1.1.2 Regional Hydrogeology

The local groundwater flow system at the Paducah Site occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and UCD, and Holocene alluvium (Jacobs EM Team 1997; MMES 1992). Four specific components have been identified for the groundwater flow system and are defined as follows from lowest to uppermost.

- McNairy Flow System. Formerly called the deep groundwater system, this component consists of interbedded sand, silt, and clay of the Cretaceous McNairy Formation. Sand facies account for 40% to 50% of the total formation's thickness of approximately 225 ft. Groundwater flow is predominantly horizontal and to the north.

- Terrace Gravel. This component consists of gravel deposits and later reworked sand and gravel deposits found at elevations higher than 320 ft above mean sea level (amsl) in the southern portion of the plant site; they overlie the Paleocene Porters Creek Clay and Eocene Sands and are thought to be Pliocene in age. These deposits usually lack sufficient thickness and saturation to constitute an aquifer. Terrace Gravel is not present in the area of the Southwest Plume sources.

- RGA. This component consists of the Quaternary sand and gravel facies of the LCD and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits are commonly thicker than the Pliocene (?-age uncertain) gravel deposits, having an average thickness of 30 ft, and range up to 50 ft in thickness along an axis that trends east-west through the plant site. Prior to 1994, the RGA was the primary aquifer used as a drinking water source by nearby residents. The RGA has not been classified formally, but likely would be considered a Class II groundwater under U.S. Environmental Protection Agency (EPA) Groundwater Classification guidance (EPA 1988). Groundwater flow is predominantly horizontal and north toward the Ohio River.

- UCRS. The UCRS consists of the surficial alluvium and UCD. Sand and gravel lithofacies appear relatively discontinuous in cross section, but portions may be interconnected. The most prevalent sand and gravel deposits occur at an elevation of approximately 345 ft to 351 ft amsl; less prevalent deposits occur at elevations of 337 ft to 341 ft amsl. Groundwater flow primarily downward into the RGA from the UCRS (DOE 2010a; DOE 2017b).

The groundwater flow systems associated with the Southwest Plume and its sources are the UCRS and the RGA. In the area of the Southwest Plume, groundwater flow and contaminant migration through the upper 45 ft to 55 ft of subsurface soil (UCD) is predominantly vertically downward with little lateral spreading. This flow system is termed the UCRS. Locally, the UCRS consists of three hydrogeologic units (HUs), an upper silt interval (HU1), an intermediate horizon of sand and gravel lenses (HU2), and a lower silt and clayey silt interval (HU3). The silts and clays of the UCRS readily adsorb some contaminants, such as metals and radionuclides, retarding the migration of these contaminants in groundwater from the source areas. Moreover, laterally extensive silt and clay horizons in the UCRS may halt the downward migration of dense nonaqueous-phase liquids (DNAPLs), but halting the movement results in potentially fostering the development of DNAPL pools in the subsurface or diffusion into fine-grain sediments, if present. Despite the possibility for pooling, to date, none of the investigations of SWMU 211-A that have installed over 50 borings in the approximately 1.5-acre area have identified the presence of any actual DNAPL pools in the subsurface. The use of TCE at PGDP is believed to have begun with the start of construction of the plant around 1952. The use of TCE at PGDP was terminated in 1993.

Groundwater occurrence in the UCRS primarily is the result of infiltration from natural and anthropogenic recharge. Groundwater in the UCRS provides recharge to the underlying RGA. The water table in the UCRS varies both spatially and seasonally due to lithologic heterogeneity and recharge factors (e.g., infiltration of focused run-off from engineered surfaces, seepage due to variations in water line integrity, rainfall, and evapotranspiration), and averages approximately 17 ft below ground surface (bgs) in depth with a range of 2 ft to 50 ft.

Downward vertical hydraulic gradients generally range from 0.5 ft to 1 ft per ft where measured by monitoring wells (MWs) completed at different depths in the UCRS. MWs in the south-central area of PGDP (south of the C-400 Building and east of the C-720 Building) have lower water level elevations than MWs in other areas of the plant (DOE 1999). Horizontal hydraulic conductivity of the UCRS sand units has been determined from 15 slug tests in a previous investigation (CH2M HILL 1992) in wells across the PGDP site. The field (horizontal) measured hydraulic conductivity of the UCRS sands was 3.4E-05 centimeters per second (cm/s) at the C-720 Building [1.3E-05 inches/second (in/s)] as measured in MW204 located at the northeast corner of the C-720 Building. Measurements of the vertical hydraulic conductivity of the UCRS silt and clay units are not available for the C-720 Building; measurements (laboratory) of the vertical hydraulic conductivity of UCRS silt and clay units on-site range between 1.7E-08 and 2.1E-05 cm/s (6.7E-09 and 8.2E-06 in/s) (DOE 1999; DOE 1999). [The depth-averaged vertical hydraulic conductivity of the total UCRS interval is approximately 1E-06 cm/s (3.9E-07 in/s).]

A thick interval of late Pleistocene sand and gravel from a depth interval of 60 to 90 ft (LCD) bgs represents the shallow, uppermost aquifer underlying most of the Paducah Site, referred to as the RGA. The RGA consists of a discontinuous upper horizon of fine to medium sand (HU4) and a lower horizon of medium to coarse sand, and gravel (HU5). The RGA is the main pathway for horizontal/lateral flow and dissolved contaminant migration off-site. Variations in hydraulic conductivity and the location of discrete sources of recharge govern the local direction and rate of groundwater flow; however, overall flow within the RGA trends north-northeast toward the Ohio River, which represents the regional hydraulic base level. The RGA typically has a high hydraulic conductivity with a range from 1.9E-02 to 2.0E+00 cm/s (7.5E-03 to 7.9E-01 in/s) as determined from aquifer testing. RGA horizontal hydraulic gradients range between 1.84E-04 and 2.98E-03 ft per ft and have average and median values of 7.81E-04 and 4.4E-04 ft per ft, respectively. Groundwater flow rates within higher hydraulic conductivity paths within the RGA average approximately 1 ft to 3 ft/day. Contaminant migration tends to be less retarded in the coarse sediments of the RGA due to its high groundwater flow rate and also due to the low fraction of organic carbon (0.02%) (DOE 2013).

1.2 TREATMENT SITE LOCATION

The treatment location for this RA is in the south-central portion of PGDP. More specifically, the treatment area lies northeast of the C-720 Building. The location of the SWMU 211-A is shown in Figure 3. The C-720 Building consists of several repair and machine shops, instrument shop, equipment and material storage area, and other support operations.

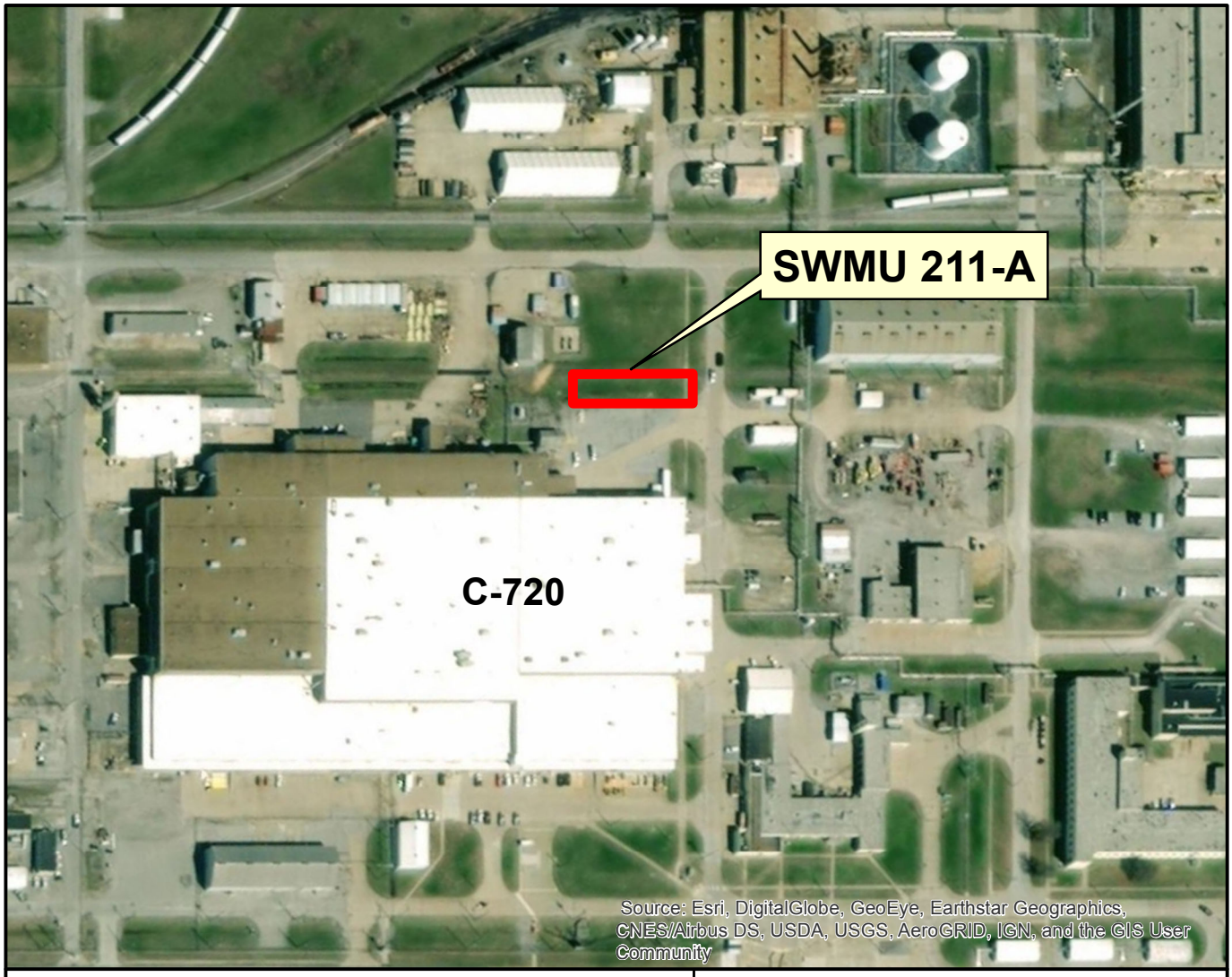
The SWMU 211-A area has been investigated several times in support of remedy selection and development of this RAWP including the WAG 27 RI (1997); Southwest Plume SI (2007); and the RDSI (2012). The RDSI was conducted in 2012 and 2015 to gather supplemental data necessary to choose a remedy and support design and implementation of the EISB with interim LUCs. Data collected during these investigations supported development of the remedial design that is contained in the *Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07–2435&D1 (DOE 2019a).

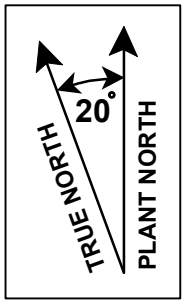
1.3 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) for the SWMU 211-A EISB RA is a three-dimensional "picture" that illustrates contaminant sources, release mechanisms, and migration routes. Figure 4 represents the CSM for SWMU 211-A and is based on all previous investigations. The source of the contaminants to SWMU 211-A is not known; however, it is suspected that SWMU 211-A originated from spills that include leaks of solvents that were released during routine equipment cleaning and rinsing performed in the cleaning area. Additionally, worker depositions collected by the Department of Justice contained the following statement from a former worker, "The barrels were filled with TCE [sic] were stored outside of the C-720 Building. Sometimes we took the barrels back to C-400 Building, but at other times, we poured the barrels' contents into a ditch on the north side of the C-720 Building" (Department of Justice, Worker Depositions, cited in KDEP 2020; EPA 2020). The Southwest Plume SI, implemented in 2004, concluded that high concentration TCE soils that would constitute principal threat waste (PTW) are present at SWMU 211-A in UCRS soils. None of the investigations of SWMU 211-A have identified actual DNAPL pools or large quantities of DNAPL in the UCRS thus far.

RDSI data were collected to support defining the area of SWMU 211-A to be treated and to confirm that EISB will be utilized as the treatment method. The RDSI data did not modify the SWMU 211-A conceptual model concerning UCRS contamination that was developed by the SI of the Southwest Plume (DOE 2007). The C-720 Building does have additional source areas near or beneath it, including SWMU 211-B, but these source areas are not being addressed by the SWMU 211-A EISB action and are not shown on Figure 4.

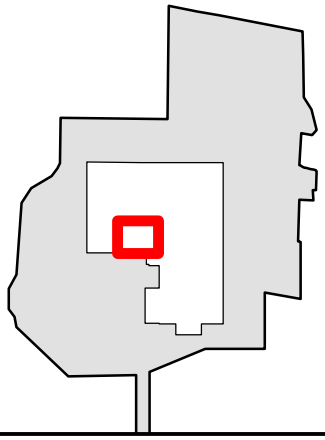
The RDSI provided updated information on the TCE and other VOC concentrations in the area to be treated. Mass quantity estimates and treatment areas were interpolated using the RDSI data, WAG 27 RI data, and the Southwest Plume SI data, and the C-Tech Environmental Visualization Systems Expert System (EVS). Volume estimates were calculated using kriging, kriging using the 90% confidence interval, inverse distance weighting, and nearest neighbor. The CFC RDR contains a summary of the EVS modeling that identified areas to be treated and estimated TCE volume contained in those areas. The complete EVS modeling information is reported in Appendix C of the *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1/R1 (DOE 2016).





0 60 120 240 360
Feet

SWMU 211



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 3. SWMU 211-A Location

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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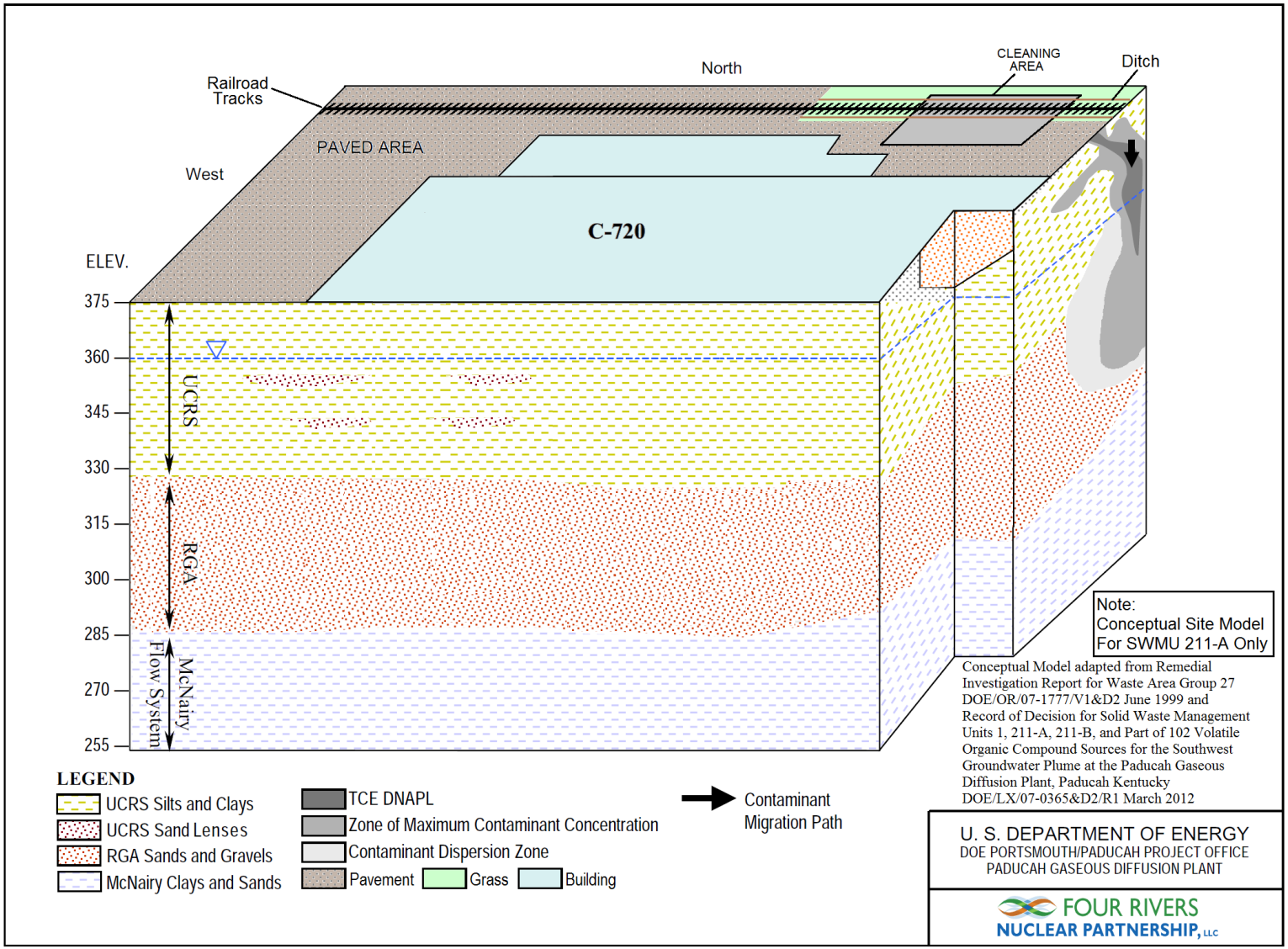

Figure 4. Conceptual Site Model for the SWMU 211-A TCE Source Area

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2. TREATMENT TECHNOLOGY

2.1 *IN SITU* SOURCE TREATMENT USING ENHANCED *IN SITU* BIOREMEDIATION DESCRIPTION

EISB implementation for SWMU 211-A will consist of the following major activities listed. A detailed description of the activities is included in the *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2435&D2 (referred to in this document as CFC RDR) (DOE 2019a).

- Hydraulic fracturing with direct push technology (DPT) Jet Injection—Utilizing DPT drilling methods and Jet Injection horizontal fractures will be emplaced at pre-planned depths with an expected radius estimated at 15 ft. The fractures will be injected with a mixture of guar gum, sand and zero-valent iron (ZVI) and an enzyme breaker. The guar gum will biodegrade with the assistance of the enzyme breaker while the sand and ZVI will become proppant to increase the hydraulic conductivity of the fracture. The ZVI will act to degrade TCE and its degradation products.

- Injection well installation—Following the completion of the hydraulic fracturing, a cluster (2–3) of injection wells (nested/offset) will be installed within 5 ft of each DPT Jet Injection location. The well and screen locations will be offset and stacked, respectively, consistent with the CFC RDR. The injection wells will be developed similarly to monitoring wells. The injection wells will be utilized to inject bioamendments and perform bioaugmentation for the treatment area.

- Monitoring well installation—MWs will be installed directly in the treatment area and also outside the treatment area. The wells inside the treatment area will monitor the bioremediation process. The MWs located outside the treatment area will be utilized to ascertain the effects the bioremediation has on the RGA groundwater and the progress toward attaining the remedial action objectives (RAOs). The MWs will be screened throughout the UCRS and in the upper and middle RGA. The MW location details are contained in the CFC RDR (DOE 2019a).

- Bioamendment injection—Emulsified vegetable oil in conditioned water (chlorine and dissolved oxygen reduced) will be injected through each injection well into the UCRS to support the bioremediation process of dechlorinating TCE and its degradation products to ethene. The emulsion allows the bioamendment to be injected further into the UCRS to allow treatment of a larger radius. As indicated in the CFC RDR, the injection pressure utilized will be variable between 15 psi and 40 psi, depending on the well's capability to receive bioamendment, but not to exceed 60 psi. Should an injection well not receive bioamendments, additional pressure up to the limit may be used and/or the well may be redeveloped. Replacement of injection wells, if needed, will be performed by offsetting the existing location and drilling, installing, and developing the replacement well. The original injection well will be abandoned to prevent it from being a conduit for bioamendments to come to the surface during the injection process.

- Bioaugmentation injection—Bioaugmentation in the form of *Dehalococcoides ethenogenes* (DHC) bacteria also will be injected into the treatment area. DHC bacteria can facilitate dechlorination of TCE completely to ethane. Testing of the SWMU 211-A subsurface did not identify the presence of DHC bacteria.

- Real Time Process Monitoring—Monitoring of parameters will be performed during the fracturing and injection processes to assist in verifying the successful placement of the materials in the UCRS. Among

these are material volume, injection pressure, geochemical readings such as dissolved oxygen, water levels in nearby wells, and surface breakthrough of injected materials.

- Performance Monitoring—Performance monitoring using MW clusters located in the remedial treatment area will be performed. This monitoring will occur before the material injections to provide baseline parameters as well as after material injections. The purpose of the monitoring is to provide an indication of the efficacy and continuity of the RA. The data also will be utilized to determine if addition bioamendment volumes are needed to insure biological activity continues in the subsurface as needed.

- Long-Term Monitoring—Long-term monitoring provides for periodic sampling of upgradient and downgradient MWs in the upper and middle RGA. The purpose of this monitoring is to determine the overall impact of the UCRS RA on reducing the migration of TCE and other VOC contaminants from the UCRS to the RGA.

A number of minor activities are associated with application of the EISB technology including the following:

- Civil surveying and utility locator service
- Conditioning of water to deoxygenate and dechlorinate for creating emulsion
- Emulsified vegetable oil solution operations
- Guar gum and ZVI mixing system operations
- High pressure water pump operations
- Solid and liquid waste management
- Health and safety and radiological (RAD) control
- Decontamination operations
- Procurement

2.2 APPLICABILITY TO THE PGDP SITE

The contamination at SWMU 211-A includes VOCs, and VOCs are the contaminants being addressed by implementing this RA. Specifically, TCE and its degradation components are present in unconsolidated and saturated soils of the UCRS. The target treatment horizon is generally 25 ft bgs to 65 ft bgs; however, some limited areas above 25 ft and below 17 ft also will be treated as designed.

There are several technical factors that form the basis for selecting bioremediation for SWMU 211-A UCRS soils and groundwater. A more complete description of the selection process for bioremediation, LUCs, and long-term monitoring at SWMU 211-A is provided in other documents such as DOE 2011; DOE 2012; DOE 2016; DOE 2015a; DOE 2017b; and DOE 2018.

Bioremediation is an effective treatment technology for TCE and its degradation components that are present at SWMU 211-A. It is a destructive technology, converting TCE (and TCE breakdown products) to ethene and ethane, which are innocuous products of reductive dechlorination. Reductive dechlorination is a well-established technology for the treatment of chlorinated volatile organic compounds (CVOCs) in soils and groundwater and is ongoing, passively, at SWMU 211-A. This is indicated by the presence of *cis*-1,2- Dichloroethene (DCE) and 1,1-DCE in groundwater in the UCRS; these are microbially mediated intermediates of reductive dechlorination. Previous investigations at SWMU 211-A have shown that TCE concentrations are acceptable for bioremediation. None of the investigations of SWMU 211-A have identified DNAPL pools or large quantities of DNAPL in the UCRS thus far. Groundwater at SWMU 211-A is slightly oxidizing, based on historical field parameter data, but reducing in some areas

because there is evidence of ongoing reduction of TCE. Amendment delivery will drive the UCRS groundwater to be more reducing and enhance these biodegradation processes by delivering the essential microbial consortium. Also by providing an electron donor in the form of ZVI during fracturing, the ZVI will generate hydrogen for assisting the biodegradation process. Concentrations of the dissolved gases ethene and ethane detected in groundwater also indicate that complete reductive dechlorination of the CVOCs has occurred in some locations in SWMU 211-A. Methane also was detected, indicating some areas within the UCRS have reducing conditions conducive to reductive dechlorination.

Please refer to Section 2.1 and 4.1 of the CFC RDR for a more detailed discussion of these technical factors and the data supporting the use of bioremediation for CVOCs at SWMU 211-A (DOE 2019a).

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3. TREATMENT SYSTEM OBJECTIVES AND UNCERTAINTY MANAGEMENT

3.1 REMEDIAL ACTION OBJECTIVES

The following are the RAOs for SWMU 211-A RA, as defined by Section 2.8 of the ROD (DOE 2012).

1. Treat and/or remove the PTW consistent with the NCP.

2a. Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to the excavation workers (< 10 ft).

2b. Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending remedy selection as part of the Soils OU and the Groundwater OU.

3. Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 Northeast and Southeast Sites so that contaminants migrating from the treatment areas do not result in the exceedance of maximum contaminant levels (MCLs) in the underlying RGA groundwater.

The RDR presents the design of the treatment systems that address the RAOs (DOE 2019a).

3.2 CRITERIA FOR CEASING REMEDIAL ACTION SYSTEM OPERATIONS

EISB, once activated with addition of amendments, will be a self-sustaining passive process. As long as the subsurface conditions remain suitable for the bacteria and there are sufficient nutrients for microbial activity, the reductive dechlorination process will continue without additional intervention. There are two goals of bioremedial operations at SWMU 211-A that will be addressed in this RA. The short-term goal of bioremedial operations is to attain subsurface UCRS conditions that allow bioremedial activity capable of dechlorinating TCE and degradation products to be accelerated and increase reductive dechlorination of the VOCs. This will be attained when performance monitoring samples indicate that concentrations of one or more TCE degradation products have increased above their baseline levels and other groundwater/geochemical parameters are suitable. Attaining this short-term goal, however, is not an indication that remediation is complete. Table 1 provides the ideal range for geochemical/groundwater parameters for EISB to occur (DOE 2019a). The information in Table 1 was reproduced from Section 4.2, Table 2, of the CFC RDR.

The long-term goal is to reduce VOC migration from contaminated subsurface soils in the treatment areas so that contaminants migrating from the treatment areas do not result in exceedance of MCLs in the underlying RGA groundwater. Data collected from the long-term MW network will be used to determine when this goal has been attained. The time frame for attaining the long-term goal is expected to require 39 years, as indicated in the ROD.

Table 1. Groundwater Parameters Matrix

Parameter	Purpose for Measuring	Ideal Range for EISB
Dissolved oxygen	Assess whether groundwater is anaerobic	< 1 mg/L
Oxidation-reduction potential	Assess whether groundwater is reducing	< -100 mV
pH	Assess whether groundwater is hospitable for bacterial activity	6 to 8 standard units
Total organic carbon	Surrogate measurement indicating the amount of electron donor in groundwater that is available to bacteria for EISB	> 10 mg/L
Nitrate, sulfate, and dissolved and total iron*	Another measure of groundwater redox as well as the natural demand for the amendments	Low nitrate, sulfate Iron in the dissolved state
DHC population	Count of the number of bacteria in groundwater that can reduce TCE to ethene	> 10^7 cells/liter
Dissolved hydrocarbon gases (ethene, ethane, and methane)	Ethene and ethane are products of complete TCE reduction; methane indicates groundwater redox is in acceptable range for EISB	Not required for EISB to occur—no target range.

*Nitrate, sulfate, and dissolved and total iron are parameters that typically are measured only before implementing EISB to understand groundwater conditions prior to implementing the RA. The oxidized and reduced forms of these parameters are used to track redox conditions in groundwater (e.g., if iron is in the dissolved phase, then groundwater redox is at or below iron reducing condition).

4. REMEDIAL ACTION APPROACH

The DOE prime contractor has overall responsibility for the design, implementation/construction, sampling and analysis, operations and maintenance, waste management, and waste disposal associated with the remedy. The major activities for this RA are outlined in this section.

Table 2 is a general list of activities typically governed by contractor procedures. Procedures referenced in the table are those followed by the current DOE prime contractor. The most current versions of all contractor procedures are to be used. The quality assurance (QA) project plan (QAPP), RAWP, CFC RDR, and all applicable procedures will be readily available in the field to all project personnel, including subcontractors, either in hard copy or electronic format. Procedures have been placed on the DOE prime contractor external website at https://pubdocs.pad.pppo.gov/?dir=SWMU%20211-A%20EISB%20Project.

Table 2. General Activities Governed by Procedures

Activity	Applicable Procedure
Accident/Incident Reporting	CP3-OP-2024, *Initial Incident/Event Reporting* CP3-ES-0003, *Environmental Incident Reporting*
Analytical Laboratory Interface	CP4-ES-5004, *Sample Tracking, Lab Coordination, & Sample Handling*
Calibration of Measuring and Test Equipment	CP4-QA-2133, *Metrology Measuring Test Equipment Calibrations and Certifications* CP3-HS-2038, *Industrial Hygiene Measuring and Test Equipment Program* CP3-SM-0017 *Measuring and Test Equipment*
Chain-of-Custody	CP4-ES-2708, *Chain-of-Custody forms, Field Sample Logs, Sample Labels, and Custody Seals*
Collection of Samples	CP4-ES-0040, *Composite Sampling* CP4-ES-2101, *Groundwater Sampling* CP4-ER-1020, *Collection of Soil Samples with Direct Push Technology Sampling* CP4-ES-2100, *Groundwater Level Measurement* CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* CP4-HS-2000, *Industrial Hygiene Sampling*
Conducting Assessments	CP3-QA-1003, *Management and Self Assessment* CP3-QA-2002, *Surveillance* CP3-OP-0500, *Performance Observations* CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-ES-0811, *Pesticide and PCB Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-ES-5102, *Radiochemical Analysis Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-ES-5103, *Polychlorinated Dibenzodioxins/Polychlorinated Dibenzofurans Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-ES-5105, *Volatile and Semivolatile Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-ES-5107, *Inorganic Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans*
Construction Equipment and Material Inspection	CP3-SM-0054, *Mobile Construction Equipment* CP3-QA-2004, *Material Receipt Inspection* CP4-SM-2103, *Inspection, Testing, Repair and Replacement of Backflow Prevention Devices*
Control of Sample Temperature	CP4-ES-0043, *Temperature Control for Sample Storage*
Decontamination of Large Equipment	CP4-ER-2701, *Large Equipment Decontamination*
Decontamination of Sampling Equipment and Small Items	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* CP4-RP-1103, *Personnel and Personal Effects Decontamination*

Table 2. General Activities Governed by Procedures (Continued)

Activity	Applicable Procedure
Document Control	CP3-OP-0025, *Document Control Process*
Documenting and Controlling Field Changes to Approved Plans	CP3-PC-0110, *Subcontract Planning and Control*
Suspect/Counterfeit Items	CP3-QA-1006, *Suspect Counterfeit Items*
MW	CP4-ES-0069, *Monitoring Well and Associated Infrastructure Installation* CP4-ES-0077, *Monitoring Well Abandonment*
Elevated Work and Fall Prevention	CP3-HS-2036, *Aerial Devices* CP3-HS-2014, *Fall Prevention Protection*
Field Logbooks	CP4-ES-2700, *Logbooks and Data Forms*
Graded Approach	CP3-QA-1001, *Graded Approach*
Handling, Transporting, and Relocating Waste Containers	CP4-WM-0019, *On-Site Transfer and Movement of Waste Containers and Other Support Equipment*
Health and Safety	CP2-HS-2000, *Worker Safety and Health Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-RP-0001, Four Rivers Nuclear Partnership, LLC, *Radiation Protection Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-HS-1000, *Integrated Safety Management System Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP3-HS-2004, *Job Hazard Analysis* CP3-SM-0019, *Electrical Safety Guidelines* CP3-HS-2010, *Instructions for Lockout/Tagout* CP2-FP-2002, *Control of Flammable/Combustible Liquids* CP2-HS-2002, *Occupational Noise Exposure and Hearing Conservation Program* CP3-HS-4002, *Implementation of the Occupational Medicine Program* CP3-HS-2055, *Confined Space*
Hoisting and Rigging Operations	CP3-SM-0051, *Hoisting and Rigging*
Inspection and Test Plans and Review of Vendor/Supplier QA Program	CP3-QA-2001, *Approved Supplier Selection, Evaluation, Approved Supplier Maintenance*
Issue Management (includes corrective action)	CP3-QA-3001, *Issues Management*
Lithologic Logging	CP4-ES-2303, *Borehole Logging*
Nonconforming Items and Services	CP3-QA-2005, *Nonconformance Control* CP3-HS-2008, *Accident Prevention/Equipment Control Tags* CP3-OP-0204, *Out of Service Equipment Control*
Powered Industrial Trucks	CP3-SM-0020, *Administrative Controls for Powered Industrial Trucks*
Quality Assured Data	CP3-ES-5003, *Quality Assured Data* CP2-QA-1000. *Quality Assurance Program Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Radiation Protection	CP4-RP-1110, *Radiation Surveys* CP3-RP-1601, *Radiation Safety Training* CP3-RP-1108, *Posting and Labeling* CP3-RP-1109, *Radioactive Contamination Control And Monitoring* CP3-RP-1104, *Radiological Area Entry Control* CP2-NS-1000, *Nuclear Criticality Safety Program Description Document at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Records Management	CP3-RD-0010, *Records Management Process*
Revisions to Procedures or Work Packages	CP3-SM-1101, *Work Package Development* CP3-SP-0019, *Subcontractor Work Planning Execution* CP3-SM-1102, *Activity Level Work Execution and Closeout* CP2-SM-1000, *Activity Level Work Planning and Control Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Security	CP3-EP-1023, *Security Emergencies*
Shared Site Issue Resolution	CP3-SI-0001, *Site Interface*
Shipping Samples	CP3-WM-9503, *Off-Site Shipments by Air Transport*

Table 2. General Activities Governed by Procedures (Continued)

Activity	Applicable Procedure
Suspend/Stop Work	CP3-HS-2009, *Stop/Suspend Work*
Temperature Extremes	CP3-HS-2000, *Temperature Extremes*
Training	CP3-TR-0102, *Conduct of Training* CP3-OP-0208, *Required Reading/Crew Briefing*
Transmission of Data	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System* CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases* CP4-ES-5007, *Data Management Coordination*
Vendor/Supplier Evaluations	CP3-RD-0012, *Contractor/Supplier Submittal Process*
Waste Management and Disposition	CP2-WM-0001, *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan* CP2-ES-0005, *Pollution Prevention/Waste Minimization Plan for the Deactivation and Remediation Project, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* CP2-WM-0011, *Waste Acceptance Criteria for the Treatment, Storage, and Disposal Facilities at the Paducah U.S. Department of Energy Site* CP2-WM-0307, *Paducah Waste Characterization Sampling and Analysis Plan* CP3-QA-2500, *Procurement, Inspection, and Management of Items Critical for Paducah Off-Site Waste Shipments* CP3-WM-0016, *Waste Handling and Storage in DOE Waste Storage Facilities* CP3-WM-3015, *Waste Packaging* CP3-WM-0437, *Waste Characterization and Profiling* CP3-WM-0022, *Waste Water Accumulation, Storage, and Disposal* CP3-WM-1017, *Safe Handling and Opening of Sealed Containers* CP3-WM-1037, *Generation and Temporary Storage of Waste Materials* CP3-WM-2110, *Waste Container Handling, Overpacking and Transportation* CP3-EP-1007, *Oil and Hazardous Materials Spills and Releases* CP3-WM-3028, *Off-Site Shipping*

Note: Construction of secondary containment for mixing areas and material storage areas details are included in Figure 14 Notes and Figure 16 Notes of the CFC RDR.

4.1 DESIGN

An RDR has been developed to support the specific implementation of this EISB RA project at SWMU 211-A (DOE 2019a). The following are the general design considerations for the RA.

- EISB will be performed on two areas of the SWMU 211-A. The total area expected to be treated is estimated at 13,200 ft^2. The areas to be treated are shown in Figure 5.

- The primary treatment depths include 25 ft bgs to 65 ft bgs with some limited areas above the 25-ft depth. Contamination located at depths shallower than approximately 17 ft bgs will be treated indirectly as contamination migrates downward through the UCRS and encounters those areas where bioremediation will occur. The migration of the shallow contamination to the depths where bioremediation is occurring is time dependent and potentially may impact the overall timeframe in attaining RAO #3.

- Because of the fine-grained nature of the UCRS soils prior to initiating the bioremediation component, each of the injection well locations will be fractured with DPT jet injection, which utilizes a water-jetting technique. Each jetted fracture will be injected with a mixture of guar gum, ZVI, an enzyme breaker, and sand to hold the fracture open for increased permeability. The enzyme breaker assists in biodegrading the guar gum. The fracture ultimately will support uniform placement of

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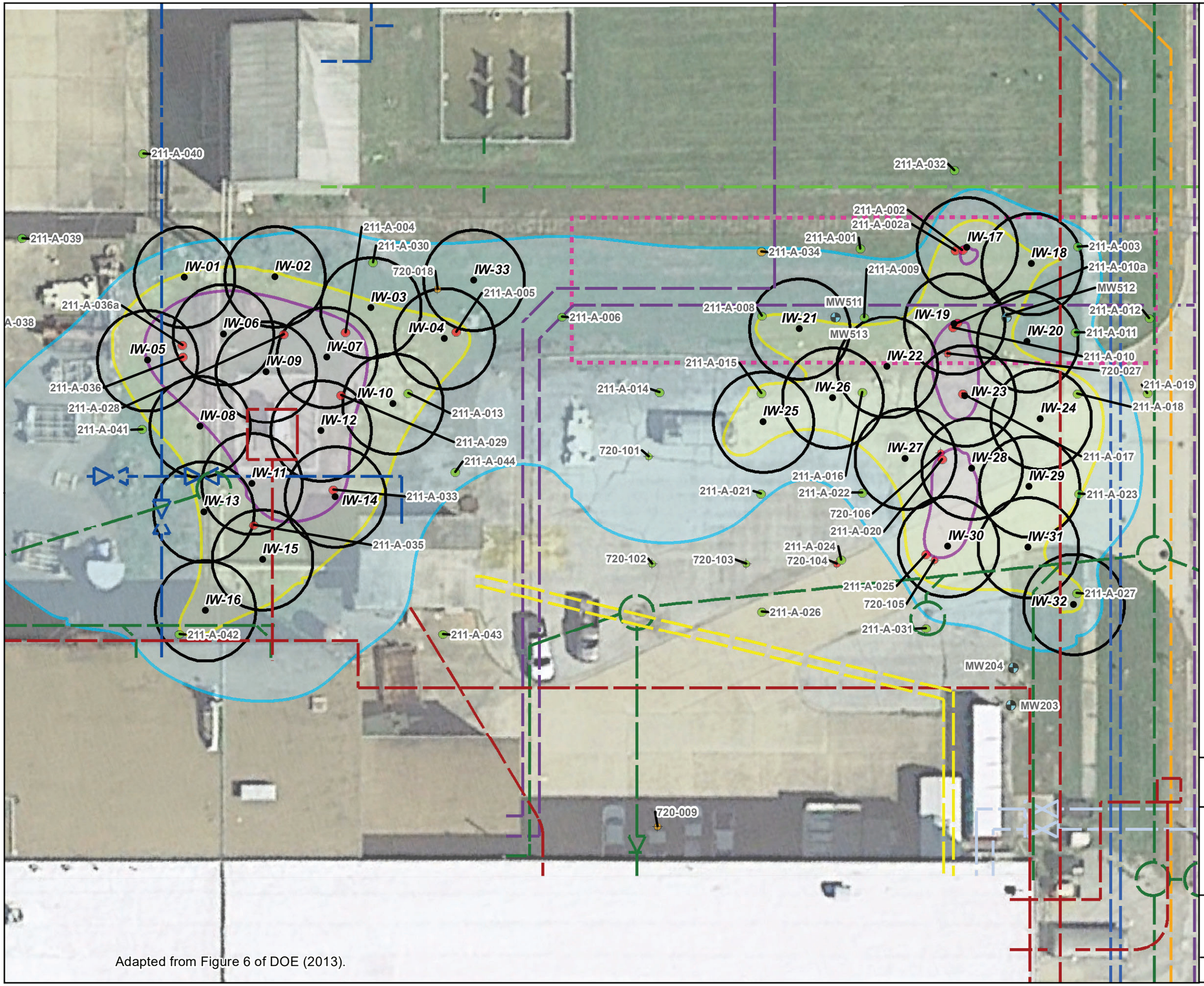

Legend

- Injection Point
- 15' Injection Point Radius
- Soil Boring Location with Average Soil Concentration Exceeding One or Both Remediation Goals (DOE 2013)
- Soil Boring Location with Average Soil Concentration Less than Both Remediation Goals (DOE 2013)
- Archive Core Soil Boring Location - Not Sampled (DOE 2013)
- Historic Soil Boring Location with Average Soil Concentration Exceeding TCE Remediation Goal (DOE 2013)
- Historic Soil Boring Location with Average Soil Concentration Less than TCE Remediation Goal (DOE 2013)
- Historic Archive Core Soil Boring Location - Not Sampled (DOE 2013)
- Existing Monitoring Well Location
- Area defined by 90% Confidence Level TCE Concentrations greater than 1,000 µg/kg
- Area defined by Nominal (50%) Confidence Level TCE Concentrations greater than 75 µg/kg
- Area defined by 90% Confidence Level TCE Concentrations greater than 75 µg/kg
- SWMU 211-A
- Gas (5'-7' BG)
- Electric (5'-8' BG)
- Storm Drain (6'-10' BG)
- Plant Water (5'-14' BG)
- Chilled Water (2'-5' BG)
- Sanitary Sewer (5'-7' BG)
- Sanitary Water (2'-5' BG)
- Cathodic Protection (3'-5' BG)
- Recirculating Cooling Water (Waste/Heat)

20° True North — Plant North

Notes:
1. TCE isopleths are based upon individual soil sample results over all depths of sampling.
2. Section 7 of the Final Characterization Report includes explanation of the modeling conducted to establish the TCE contours based upon confidence levels.
3. Source of 2018 Aerial: Google Earth.
4. Existing monitoring wells MW511, MW512, and MW513 will be abandoned prior to performing injections.

30 15 0 30 Feet

SWMU 211-A Planned Injection Layout

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

Figure 5

October 2019

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Figure 5. SWMU 211-A Planned Injection Layout

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bioamendments. The guar gum will degrade and assist the vegetable oil in developing reducing subsurface conditions allowing the reductive dechlorination to occur. The ZVI will assist by abiotically reducing the volatile contaminants. The sand will act as a proppant to hold-open the fractures locally increasing the permeability of the UCRS soils and providing for more uniform distribution of amendments.

- An estimated 33 injection well locations will be utilized to place an emulsified vegetable oil and water mixture into the subsurface to act as an electron donor for transforming the UCRS locally into a reduced environment allowing the reductive dechlorination of the volatiles to proceed. Each injection will provide an injection radius of influence of approximately 15 ft and will overlap other injection well areas approximately 30%.

- The emulsified vegetable oil injected into each injection well will be pumped using low pressure estimated at 15 to 40 psi (not to exceed 60 psi) and in a volume of up to 2% by volume of pore space. The estimated quantity of emulsified vegetable oil (EVO) solution to be injected is 123,200 gal. Injection rates are expected to exceed 0.5 gpm.

- Bioaugmentation of each injection well also will be performed with DHC bacteria. The bacteria have the capability to dechlorinate TCE and its degradation products effectively through to ethane.

- Water conditioned to remove dissolved oxygen to assist in creating the subsurface reducing environment will be utilized to emulsify the vegetable oil for injection. See Section 5.3 of the CFC RDR for details.

- Real time process monitoring will occur during the injection processes and will include the following observations and measurements:

  — Quantities injected,
  — Injection pressures,
  — Injection flow rates,
  — Observe ground surface for potential breakthroughs during injection operations,
  — Monitor water levels in nearby monitoring and injection wells, and
  — Measure chemical parameters of injection materials.

- Post-injection monitoring will be performed utilizing a network of 9 MWs located external to the treatment area and 18 MWs internal to the treatment area. The wells will be screened in the UCRS and the RGA.

4.2 CONSTRUCTION

The progress of the construction phase of the SWMU 211-A RA will be phased and is outlined below.

- Contracting/Procurement
  — Site Preparation Contract/Task Order
  — Drilling Contract/Task Order
  — Bioremediation Contract/Task Order
  — Posttreatment Sampling Contract/Task Order

- Mobilization

- Site Preparation
  - Clearing Treatment Area
  - Waste Management and Decontamination
  - Surveying and Utility Clearing

- EISB
  - DPT Jet Injection Fracturing
    - Drilling site preparation and concrete coring
    - Injectant mixing equipment setup
    - Drilling, fracturing
  - Bioamendment Injection Well and MW Installation
  - EISB Amendment
    - Amendment equipment setup
    - Amendment preparation
    - Augmentation preparation
    - Amendment, augmentation injection, and monitoring
  - Demobilization
  - Posttreatment Performance and Long-Term Monitoring

Multiple procurements/task order releases are expected to be needed. Depending on the qualifications of the contractors, tasks may be combined to reduce the need for additional procurements. Procurements or task orders will be needed for drilling and bioremediation specialty services and sampling and analysis. Analysis will be performed through a task order initiated by DOE's Sample Management Office (SMO) contract laboratory.

The treatment area is directly adjacent to an occupied building which has activities that occur in or near the treatment area. To initiate field activities, the area will need to be cleared, to the degree possible, of vehicles and mobile equipment. There are some fixed equipment such as guardrails and parking blocks that may be removed to increase access to the area.

Mobilization of the equipment for implementing the RA will include drilling equipment, amendment material, mixing and preparation equipment for the Jet Injection activities as well as the placement of bioremediation amendments and bioaugmentation cultures. Drilling for the RA will include direct-push technology equipment for the Jet Injection fracturing. Injection and MWs will be installed with a more robust drilling technology such as RotoSonic or other approved equal.[1]

After the initial mobilization, DPT Jet Injection will be used at each injection well location to induce fractures in the UCRS as planned in the CFC RDR, Table 5. The fracturing process will utilize high-pressure water jetting equipment to cut fractures in the UCRS formation and pump a mixture of guar gum, sand, and micro-scale ZVI into each fracture to hold open the fracture in order to receive bioremedial amendments more efficiently. The guar gum, sand, and micro-scale ZVI will be prepared at the surface utilizing mixing

[1] Throughout this report, when an approved or acceptable substitution is discussed, the FRNP Project Manager will approve or disapprove the recommended equal. A periodic (weekly) teleconference will be scheduled with the FFA parties during the fieldwork period to discuss the status of activities and modifications that may have been made or are being considered. The modifications made will be reported in the Interim Remedial Action Completion Report (RACR), which will include postconstruction report elements and will be submitted in the near-term.

equipment as described in the CFC RDR and shown in Figure 14 of the CFC RDR (DOE 2019a). In order to induce fractures in the UCRS effectively and to minimize damage to infrastructure, three existing MWs will be abandoned. The MWs are MW511, MW512, and MW513; they are completed in the UCRS and are located within the planned treatment area. They were installed as part of the RDSI performed in 2012. New wells will be installed as part of the performance monitoring that effectively replaces those wells being abandoned.

After inducing the fractures in the UCRS, a second drilling phase will be performed to construct the performance MWs and the long-term MWs to be used for the RA. The performance MWs will be drilled within the area to be treated and will be completed in the UCRS and the upper RGA. Their use will be to monitor key parameters to determine the status of the bioremedial activity as it occurs in the subsurface. The long-term MWs will be installed outside of the area to be treated in both upgradient and downgradient locations and will be completed in the RGA. The MWs and performance MWs will be utilized to obtain a baseline of groundwater characteristics prior to initiating bioremedial activity. The monitoring parameters are discussed in the Operation, Maintenance, and Environmental Monitoring Plan, included as Appendix A of the CFC RDR (DOE 2019a). The injection wells for performing the bioamendment and bioaugmentation additions also will be installed as described in the CFC RDR as part of this drilling program (DOE 2019a).

Actual initiation of the bioremedial action will occur after the completion of the UCRS fracturing, the installation of the performance monitoring and long-term MW networks, and injection well installations. This phase which is detailed in the CFC RDR will utilize a surface equipment system to prepare an emulsified solution of vegetable oil and water as shown in CFC RDR, Figure 15. The water utilized will be preconditioned to reduce the dissolved oxygen content so as not to inhibit bioremedial activity (see Section 5.3 of the CFC RDR for details). Bioaugmentation with DHC will occur also during this phase. Upon completion of this phase, the RA will have been initiated in the subsurface.

Post-injection monitoring will occur following the bioremedial initiation. This phase of the operation will include sampling the performance and long-term MWs as prescribed in Appendix A of the CFC RDR. Bioremediation associated with EISB generally persists, provided the geochemistry of the treatment area allows the DHC to survive and there are VOCs and EVO to support the DHC. The post-remedial monitoring will provide the data to assess the status of the subsurface remedial measure. Should it become necessary to add EVO to the system, the approach will be in accordance with the Operations, Maintenance, and Environmental Monitoring Plan, Appendix A of the CFC RDR.

4.3 SAMPLING AND ANALYSIS

Performance sampling and long-term sampling are components of this EISB RA project. The sampling associated with each of these components is included in the CFC RDR, Appendix A (DOE 2019a). The need for and schedule for EISB maintenance injections and changes to monitoring frequency will be a decision made at the discretion of the FFA parties and the project team based on the results of performance monitoring groundwater samples.

4.4 INJECTION OPERATIONS MONITORING

The implementation of the EISB RA project will include injection of materials in the creation of the fractures and also with the insertion of amendments needed to create subsurface conditions allowing bioremediation to occur. The monitoring that is to be performed as these injections occur is discussed in Section 4 and Appendix A of the CFC RDR (DOE 2019a).

4.5 WASTE MANAGEMENT AND DISPOSITION

Waste generated during the implementation of the SWMU 211-A project RA will be managed and dispositioned in accordance with the waste management plan (WMP) and applicable or relevant and appropriate requirements (ARARs). Waste characterization will be performed using analytical results from waste sample analysis and/or a combination of process knowledge where applicable. Refer to the WMP in Section 12 for additional detail concerning waste management and disposition.

5. PROJECT ORGANIZATION

The project organization chart is provided as Figure 6. Plan-of-the-day/prejob briefings will provide personnel an opportunity to discuss daily activities and any issues. All personnel have "stop work authority" and the responsibility to use this authority in accordance with CP3-HS-2009, *Stop/Suspend Work,* when they believe the work poses imminent danger to workers, public, or the environment. The following paragraphs provide a summary of the work duties associated with certain project positions.

- DOE—Lead agency. DOE performs oversight of FRNP and the project. DOE reviews and approves project documents and participates, as needed, in field assessments. DOE also is responsible for communications with the EPA, state regulatory agencies, and the general public.

- Health, Safety, Security, & Quality (HSS&Q) Director—Provides supporting services for implementing the RA at SWMU 211-A. The following list includes the services and resources.

  — QA Specialist
  — Health and Safety Specialist
  — Safeguards and Security Services
  — Industrial Hygienist Specialist
  — Radiation Control Technicians
  — Fire and Emergency Response Services
  — Training Support Services
  — Occupational Medicine Services

- Technical Services Director—Provides supporting services needed for implementing the RA.

  — Engineering Services
  — Landfill Services
  — Nuclear Safety Services
  — Surveying Services
  — Transportation Services
  — Waste Management Facilities and Services
  — Waste Engineering Resources
  — Waste Specialist

- Environmental Remediation (ER) Manager—Serves as the primary point of contact with DOE for ER programs. Performs work as the management contact in accordance with the baseline scope and schedule and directs the day-to-day activities of DOE contractor personnel performing environmental monitoring and restoration activities. Serves as the primary management contact for implementation of the RA. Services and resources provided by ER Manager include subject matter experts in the following areas:

  — Project Management Services
  — Geological Services
  — Remediation Services

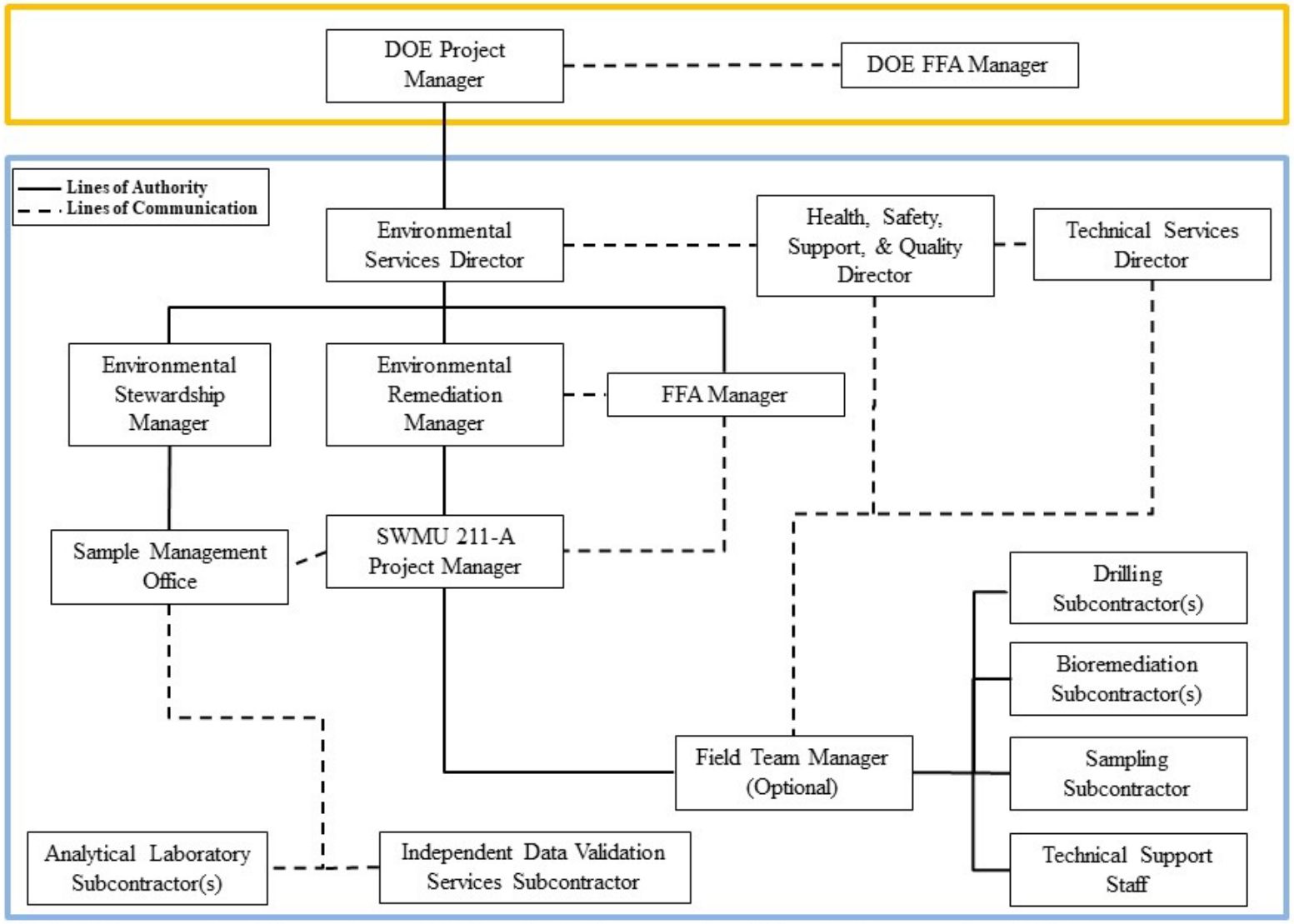

Figure 6. Project Organization

- Environmental Services Director—Provides supporting environmental services needed for implementing the RA. Provides environmental support and oversight to the project to ensure that the planning and fieldwork are being performed properly and in accordance with all applicable regulations, DOE directives, and relevant plans and procedures. The Director also serves as the point of contact with DOE for all ER activities implemented by DOE prime contractor; resources provided by the Environmental Services Director's organization include the following:

  — Environmental Compliance Services
  — SMO Laboratory Services
  — Independent Data Validation Services
  — Field Support and Sampling Personnel

- SWMU 211-A Project Manager—Serves as the RA point of contact for technical matters and will be responsible for the performance, quality, and schedule for implementing EISB RA project at SWMU 211-A. Provides overall project direction and execution, implements necessary corrective actions, verifies compliance with safety and health requirements, and participates in the field assessment analysis. May be the technical contact for subcontracted project support and should ensure that the flow down of data management requirements is defined in a statement of work (SOW).

- Field Team Manager (Optional)—Supports Environmental Services Director and SWMU 211-A Project Manager to ensure established and approved designs, work plans, and procedures are performed as required. Supervises the field team activities and field data collection. Ensures that all field activities are properly recorded and reviewed in the field logbooks and on any necessary data collection forms. Responsibilities include identifying, recording, and reporting project nonconformances or deviations. Interfaces with the SWMU 211-A project manager during field activities. (Note: If the Field Team Manager position is not designated, the requirements of the position will be performed by the SWMU 211-A Project Manager.)

- Sample Management Office—Provides support services in the area of analytical analyses, data management, data verification, and independent data validation. Ensures that hard copy data records are processed according to data records management requirements. Works with field teams to facilitate data collection and with data users to ensure easy access to the data. Ensures that analytical methods, detection limits, minimum detectable activities, laboratory quality control (QC) requirements, and deliverable requirements that are specified in the SOW are utilized and that the SOW incorporates necessary deliverables so that data packages from the laboratory can be verified and validated successfully. Responsible for contracting any fixed-base laboratory utilized during sampling activities. Incorporates any existing data or new project data into the project's hardcopy data record file or database, as appropriate. Ensures that analytical and field data are validated, as required, against a defined set of criteria that includes evaluating associated QC samples to ensure that analyses were preformed within specified control parameters. Performs data reviews, as appropriate [e.g., quality checks; assessing sensitivity, precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameter conformance; evaluating adherence to data quality requirements]. Ensures that the project data are properly incorporated into Paducah Oak Ridge Environmental Information System (Paducah OREIS).

- Technical Support Staff—Provides direct support to the Field Team Manager and SWMU 211-A Groundwater Operable Unit project manager concerning technical aspects of the project during remedial design, construction, drilling, equipment operation, civil survey, sampling operations, and associated operations.

- Subcontractor(s)—A number of subcontractors are expected to be utilized in performing this RA. A bioremediation specialty subcontractor will provide equipment and expertise during the implementation of the RA. Depending on subcontractor qualifications, a separate subcontractor may be needed to perform the needed drilling and fracturing of the UCRS soil. A subcontract laboratory will be retained for analytical services.

6. PROJECT PLANNING SCHEDULE

A generalized project planning schedule is shown in Table 3. A task-level-specific schedule will be developed and updated once the necessary subcontractors are selected and the work is scheduled. Once these schedules are available, they will be provided to the FFA parties for use.

Table 3. Project Planning Schedule*

Activity	Time Frame
Mobilization	1st Quarter 2022
Initiate Fracturing and Drilling Operations	2nd Quarter 2022
Initiate EISB Implementation	3rd Quarter 2022
Initiate Post-implementation Sampling and Monitoring	4th Quarter 2022
Issue D1 Interim Remedial Action Completion Report+ (FFA Milestone)	March 30, 2023

*Projected calendar year schedules for completion of activities set forth herein are estimates provided for informational purposes only and are not considered to be enforceable elements of the RA project or this document. The enforceable milestones for performance of activities included as part of the RA project are set forth in the FFA (EPA 1998). Any additional milestones, timetable, or deadlines for activities included as part of the RA project will be identified and established independent of this RAWP, in accordance with existing FFA protocols.

+The Interim RACR will include Postconstruction Report elements and will be submitted in the near-term. A final RACR will be submitted in the future upon achievement of the long-term RAOs and remedial goals identified in the ROD for this SWMU.

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7. HEALTH AND SAFETY

7.1 PURPOSE

The purpose of this Health and Safety section for the SWMU 211-A RA is to identify the potential hazards associated with the activities that support DOE and to outline proper control methods to protect the workers, the public, and the environment from potential harm in accordance with CP2-SM-1000, *Activity Level Work Planning and Control Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. This Health and Safety section will be used with other health and safety documentation as needed to support the implementation of the SWMU 211-A RA.

The RA tasks will be performed in accordance with the Hazardous Waste Operations and Emergency Response (HAZWOPER) regulation 29 *CFR* Part 1910.120, as applicable. This section was developed to meet the requirements of DOE prime contractor procedures. This section also is to be used in conjunction with CP2-HS-2000, *Worker Safety and Health Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*; CP2-RP-0001, *Radiation Protection Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*; CP2-HS-1000, *Integrated Safety Management System Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*; and any applicable DOE prime contractor procedures.

7.2 INTEGRATED SAFETY MANAGEMENT/ENVIRONMENTAL MANAGEMENT

The SWMU 211-A RA project is committed to implementing an Integrated Safety Management System (ISMS)/Environmental Management System (EMS) that integrates personnel and environmental safety into management and work practices at all levels so that missions are accomplished while protecting the public, the workers, and the environment. The concepts of the ISMS/EMS will be utilized to provide a formal, organized process to ensure the safe performance of work. The CP2-HS-1000, *Integrated Safety Management System Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, integrates EMS and identifies the methodologies that will be used to address previously recognized hazards and how the hazards are being mitigated using the DOE prime contractor-accepted HSS&Q practices.

The core functions and guiding principles of ISMS/EMS will be implemented by incorporating applicable programs, policies, technical specifications, and procedures from DOE, U.S. Occupational Safety and Health Administration (OSHA), EPA, DOE prime contractor, and other applicable regulatory guidance. Brief descriptions of the five ISMS/EMS core functions are provided below.

7.2.1 Define Scope of Work

Defining and understanding the scope of work are the critical steps in successfully performing any specific activity in a safe manner. Each member of the project team will participate in discussions conducted to understand the scope and contribute to the planning of the work. The project team will meet to ensure that everyone understands the scope of work and the technical and safety issues involved. These meetings are conducted to ensure all parties of the project team are in agreement on the scope and approach to complete the work.

7.2.2 Analyze Hazards

In the course of planning the work, the project team will identify hazards, including personnel safety and environmental risks associated with the performance of the work. Hazards may be identified and assessed

by performing a site visit, reviewing lessons learned, and reviewing project plans or historical data. The hazard assessment process is described in procedure CP3-HS-2004*, Job Hazard Analysis*.

Once the hazards have been identified and assessed, measures will be identified to minimize risks to workers, the public, and the environment. These measures are described in the project-specific job hazard analysis (JHAs) or work instructions. These measures provide a control mechanism for all work activities. JHAs are detailed, activity-specific evaluations that address the hazards associated with the tasks and/or activities that will be performed. The JHA development process is a detailed evaluation of each task to identify specific activities or operations required to complete the scope of work successfully and define the potential chemical, physical, radiological, and/or biological hazards that may be encountered; the media and manner in which they may occur; and how they are to be recognized, mitigated, and controlled. Appropriate hazard controls may include engineering controls, administrative controls, and the use of personal protective equipment (PPE). The project team is responsible for the preparation, revision, and implementation of JHAs and hazard controls.

Applicable JHAs and hazard controls will be reviewed with assigned personnel who will perform the work. Participants in this review will sign and date the JHA or applicable work control to signify that they understand all hazards, controls, and requirements in the work control/JHAs. Copies of the work control documents/JHAs with appropriate signatures shall be maintained and readily accessible.

7.2.3 Develop and Implement Hazard Controls

Project-specific plans and technical procedures are the primary mechanisms used to flow down ISMS/EMS controls to the project team. Other mechanisms include program/project management systems, employee training, communication, work site inspections, independent assessments, and audits. These mechanisms are communicated in the following ways:

- Prejob meetings
- Training
- Plan-of-the-day/prejob briefings
- JHAs
- Radiological work permits (RWPs)

The plan-of-the-day/prejob briefing incorporates the principles of ISMS/EMS. The specific steps within ISMS/EMS are emphasized to each employee. It is emphasized that no employee will be directed or forced to perform any task that he/she believes is unsafe, puts his/her and/or coworker's health at risk, or that could endanger the public or the environment. One of the key elements of ISMS/EMS is that all personnel have "stop work authority" and are encouraged to use this authority whenever they perceive the safety of workers, the public, or the environment to be at risk.

Employee involvement is emphasized in training sessions and in briefings/meetings. Employees are encouraged to participate in the selection, development, and presentation of training/meeting topics, and their full and constructive input is encouraged in all communication sessions.

7.2.4 Perform Work

After the project team has been given approval to proceed, the project-specific plans will be implemented. The SWMU 211-A RA project team will verify that all applicable plans, forms, and work controls are in place prior to execution of work. The following measures will be taken during the performance of the work to incorporate ISMS/EMS principles.

- Plan-of-the-day/pre-job briefings
- Project safety meetings
- HSS&Q oversight/inspections
- Safety inspections
- Equipment inspection
- Stop work authority

7.2.5 Feedback/Improvement

Feedback and improvement are accomplished through several channels, including ISMS/EMS audits, self-assessments, employee suggestions, lessons learned, and postjob briefings.

The DOE prime contractor or project management will encourage employees to freely submit suggestions that offer opportunities for improvement and constructive criticism on the program. Project management will conduct periodic inspections in accordance with CP3-OP-0050, *Performance Observations,* and meetings with project personnel at the work site to discuss safety/environmental issues and/or concerns, as well as other relevant topics.

During field activities, meetings and briefings will provide opportunities for project personnel to communicate the following:

- Lessons learned and any other topics relevant to the work performed;
- How work steps/procedures could be modified to promote a safer working environment;
- How communications could be improved within the project team; and
- Overall issues or concerns they may have regarding how the work was performed.

7.3 FLOW DOWN TO SUBCONTRACTORS

The DOE prime contractor's approach to HSS&Q ensures that personnel, including subcontractors, are aware of their roles, responsibilities, and authorities for worker/public safety and protection of the environment. DOE prime contractor subcontractors will be responsible for compliance with the DOE prime contractor's Worker Safety and Health Program. Personnel will have the appropriate health and safety training required by OSHA 29 *CFR* Part 1910.120, HAZWOPER, but also will undergo site-specific prejob training including safety and environmental topics to ensure that HSS&Q issues related to the activities to be performed or specific to the work site are understood clearly. Documentation of personnel training and qualifications will be available for review prior to starting work.

7.4 SUSPENDING/STOPPING WORK

In accordance with procedure CP2-HS-1000, *Integrated Safety Management System Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, employees and subcontractors have suspend/stop-work authority and responsibility. This process is defined and governed by procedure CP3-HS-2009, *Stop/Suspend Work*. Individuals involved in any aspect of the project have the authority and responsibility to suspend or stop work for any perceived threat to the safety and health of the workers, other personnel, or to the environment.

DOE will implement the EISB RA consistent with the FFA Section XXII, Creation of Danger. As such, notifications will be provided for stop-work determinations that meet the required conditions as stipulated in FFA Section XXII.

7.5 HEALTH AND SAFETY BRIEFINGS

Plan-of-the-day/prejob briefings detailing the specific hazards of the work to be performed and safety precautions and procedures specific for the job shall be conducted by the subcontractor, Frontline Supervisor, and/or industrial safety (IS)/industrial hygiene (IH) specialist at the beginning of each shift. During these briefings, work tasks and the associated hazards (personnel safety and environmental risks) and mitigating controls will be discussed using task-specific work control documents, JHAs, and/or lessons learned as guidance.

Prior to performing work on the site, personnel shall be required to read, or be briefed, on the DOE prime contractor's Worker Safety and Health Program, the HASP, applicable JHAs, the work package, and other applicable work control and project related documents. This shall be documented on acknowledgement forms, briefing sheets, or as required reading. Visitors also will be oriented to the applicable plans and potential hazards that they may encounter.

7.6 SITE BACKGROUND/SCOPE OF WORK

Site background and scope of work information can be found in Sections 1, 2, 3, and 4 of this document.

7.7 KEY PROJECT PERSONNEL AND RESPONSIBILITIES

One of the primary underlying principles of a successful project organization is the establishment of clearly defined roles and responsibilities and effective lines of communication among DOE prime contractor employees at the Paducah Site, subcontractors, and other organizations. Ensuring that personnel fully understand their roles and responsibilities and that they have a thorough understanding of the scope of work and other project requirements will provide the foundation for successful and safe completion of the project. Individuals and responsibilities will be identified for the various project tasks in the applicable work packages/instructions and communicated to personnel prior to work.

Section 5 identifies the roles and responsibilities of key personnel associated with the implementation of the HASP. Each team member shares the responsibility of accomplishing the scope of work; achieving required quality; participating in work planning and JHA development; and maintaining compliance with laws, regulations, and DOE Orders and Directives in a safe working environment. In general, it is the responsibility of every DOE prime contractor employee and subcontractor to ensure that work performed is accomplished in a safe and professional manner.

Examples of additional support personnel who fall under the HSS&Q director (key personnel identified in Section 5) and who may support the project are included below.

7.7.1 DOE Prime Contractor Industrial Safety/Industrial Hygiene Specialist

The IS/IH specialist is a representative from the IS or IH groups and is responsible for the following.

- Identifies standards and provides oversight of safety and health compliance and training.
- Provides independent oversight for S&H.
- Assists the Frontline Supervisor in verification of employee suitability for work based on the employee's training and physician's recommendation.

- Advises personnel of potential exposures and consequences.
- Assists in hazard analysis and ensures that JHAs are developed and maintained properly.
- Conducts inspections, as necessary, to verify proper implementation of the Worker Safety and Health Program.
- Notifies the plant shift superintendent (PSS), Frontline Supervisor, and site personnel as required in the Worker Safety and Health Program, DOE prime contractor's procedures, and the HASP.
- Completes all IS/IH specialist documents and records as required by the DOE prime contractor's plans and procedures.
- Participates in accident/incident investigations.

7.7.2 DOE Prime Contractor Quality Assurance Specialist

The QA specialists may be responsible for certain aspects of program implementation and/or assisting project and functional management in the implementation of the QA Program requirements within his/her area of responsibility. Other activities include, but are not limited to, the following responsibilities.

- Reviews work control documents, applicable plans, and procedures, as needed for QA requirements.
- Performs and documents scheduled QA independent assessments and/or surveillances to evaluate the adequacy of project, functional, and subcontractor organization's implementation of QA Program and Implementation Plan requirements.
- Participates in readiness/operational reviews of projects and activities.
- Tracks and trends identified issues and corrective actions in the Issues Management Database.
- Identifies problems to management that hinder organizational effectiveness or contract performance.
- Reviews nonconformance documentation and submits the documentation for nonconforming or suspect/counterfeit items for entry into the DOE nonconformance tracking system database.
- Provides support as required for reportable occurrences, as requested by the organizations responsible for the events.
- Assists line organizations in problem identification, causal analysis, and lessons learned development.
- Implements procedures governing the identification, evaluation (screening), and reporting of potential noncompliances.
- Assists in the development and revision of issues management reports for nonconforming items.

7.8 GENERAL PROJECT HAZARDS

7.8.1 Operation of Project Vehicles and Equipment

All field personnel operating vehicles shall have a valid operator's license and authorization for the type of vehicle being operated, drive responsibly, and comply with posted speed limits. All vehicle occupants shall use seat belts, where available, while project vehicles are in operation, and drivers also shall comply with project-specific training requirements. The use of cellular phones or other potentially distracting activities while driving on company business is prohibited. Operators shall walk around the vehicle and check for obstacles and material prior to backing up. Use of a spotter is recommended when backing vehicles as well.

Large vehicles and heavy equipment, such as excavators, cranes, and forklifts, have blind spots and the potential for pinch and crush hazards. Drill rigs also include the hazard of rotating equipment during operations. Heavy equipment shall have a functioning back-up alarm or a spotter will be required when the vehicle is backing up in congested areas. The spotter shall not stand directly behind the equipment while backing.

Equipment operations will be in accordance with the DOE prime contractor procedure CP3-SM-0020, *Administrative Controls for Powered Industrial Trucks.*

7.8.2 Tools and Equipment

Tools and equipment shall be inspected visually prior to each use to ensure that the devices are in good working order. All guards and safety devices (e.g., power tools) shall be in place when the equipment is in use. The individual conducting an inspection should look for signs of wearing (e.g., frayed power cords, loose parts), missing components (e.g., lock pins, guards), and any indication of a potentially unsafe condition. Deficiencies affecting safe operation of project equipment shall cause the equipment to be taken out of service until properly repaired. The DOE prime contractor's field equipment and tools shall be operated only by knowledgeable personnel with appropriate work experience and awareness of the hazards and safe operating procedures of the devices, as applicable. This determination is to be made by the Frontline Supervisor, IS/IH specialist, or his/her designee.

7.8.3 Material and Drum Handling

Material handling will be accomplished using safe lifting procedures. Mechanical lifts and/or carts will be used whenever possible. Whenever moving or lifting objects, travel paths and actions should be considered prior to initiating the work. Drum-handling activities include the general handling, transport, and opening and closing of drums along with the storage of wastes within the drums. These activities shall be performed in accordance with CP3-WM-1017, *Safe Handling and Opening of Sealed Containers,* and only by individuals who are knowledgeable in the use of appropriate techniques, drum-handling equipment, and safety devices. Drums/containers will be handled as to avoid spills or releases, such as using spotters when using forklifts to pick-up or move containers and place containers with liquids in/on secondary containment when not in transit.

Drums containing wastes or material could become pressurized and must be inspected prior to handling or opening and periodically, as required. If the container/drum appears to have a swollen lid, side, or bottom and/or emits a hissing sound, consider the container to be pressurized. Do not touch, move, or disturb the container and report it to the Frontline Supervisor and/or IS/IH specialist immediately for appropriate actions. Empty drums also must be inspected prior to opening, since they may be pressurized if subjected to changing temperatures. Drum webs or other restraining device should be used when opening any container suspected of having pressure to prevent injury from flying lids and or closure rings.

7.8.4 Electrical Service

DOE prime contractor personnel using portable generators shall ensure that the units are grounded, as required, prior to use. To provide additional worker protection, ground-fault circuit interrupters will be used at the primary power distribution location whenever portable electrical equipment powered by 120-volt alternating current is used. Whenever possible, electrical cords will be routed out of traffic areas or adequately shielded. As with other field equipment, all cords should be inspected before use, and any damaged equipment shall be removed from service and a defective equipment tag attached until replaced or repaired. Personnel will adhere to requirements set forth by National Fire Protection Association 70E and CP3-SM-0019, *Electrical Safety Guidelines.*

CP3-HS-2010, *Instructions for Lockout/Tagout*, establishes the requirements for the lockout/tagout (LOTO) of energy sources and the use of LOTO work permits at the Paducah Site. This program applies to all energy sources including electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other sources in machines and equipment that can be hazardous to workers. During the servicing and maintenance of machines and equipment, the unexpected startup or release of stored energy could cause injury to employees. LOTO permitting will be used for the protection of personnel, be established for planned or anticipated maintenance/support activities, and required if unexpected operation or energizing could cause injury.

7.8.5 Fire Safety

Refueling equipment can present a significant fire/explosion hazard if subjected to sparks, static electricity, or other ignition sources. Subcontract personnel who handle/transfer containers with flammable liquids to another container shall be bonded appropriately prior to use. Only safety containers approved by the Factory Mutual Research, Underwriters Laboratories, or U.S. Department of Transportation will be used to transport and store these liquids. Site personnel are to ensure that the equipment used to transfer the liquids is approved for the material being handled, and personnel should take precautions to prevent overfilling and spill/drips. Safety cans shall be labeled as to their contents and properly secured during transport. When applicable, equipment should be given adequate time to cool down before refueling. During refueling operations, a 20-B:C rated fire extinguisher will be within 50 ft of the operation.

Smoking will not be allowed in the work area or radiologically controlled areas. Smoking will be allowed in designated areas and cigarette butts properly discarded to prevent litter or pose a fire risk. Personnel shall adhere to CP2-FP-2002, *Control of Flammable/Combustible Liquids.*

7.8.6 Housekeeping

Good housekeeping, including routine site cleanup and waste management, shall be practiced at all times to improve the general safety of the site activities. Housekeeping efforts may include eliminating or minimizing slip, trip, and fall hazards. Sanitary trash shall be containerized and disposed of periodically. Supplies, materials, and ancillary equipment should be stowed properly when not in use, and walk areas shall be kept free of obstructions.

7.8.7 Slips, Trips, and Falls

The work locations, especially excavations, rough terrain, and surface obstructions, may pose hazards causing slips, trips, and/or falls. Care should be taken when working around uneven terrain, and obstructions should be kept out of walkways. Slipping hazards, such as grease, oil, water, or other liquids, shall be cleaned up immediately or addressed in work areas and packaged appropriately after cleanup as warranted.

7.8.8 Head, Eye, Hand, and Foot Hazards

Work activities have potential hazards that may result in injuries to the head, eyes, hands, or feet. The use of engineering controls (such as ensuring that appropriate machine guarding is in place) or administrative controls (such as restricting personnel from encroaching in machine operating areas) have limited applications for these hazards. The use of PPE may be necessary to address these hazards adequately. Where these hazards exist, the task-specific JHA, work instruction, and/or RWP will specify the use of appropriate PPE, including American National Standards Institute (ANSI)-approved hard hats, safety eye protection, gloves (as required), and safety-toed footwear or composite safety shoes.

7.8.9 Elevated Work

Mobilization, demobilization, and routine-maintenance of equipment will require elevated work for assembling the equipment. Fall protection shall be used for elevated work, and operators of man lifts shall be trained and follow manufacturer's procedures for their operation. All elevated work activities will follow CP3-HS-2036, *Aerial Devices*, and CP3-HS-2014, *Fall Prevention and Protection*.

7.8.10 Kinetic Energy

All kinetic hazards must be protected against any harm to personnel. Kinetic energy is associated with motion or the potential for motion. Motion hazards most commonly are linked to mechanical energy, but other forms of movement are hazards.

7.9 SUSPECTED CHEMICAL AND RADIOLOGICAL HAZARDS

TCE. As previously mentioned, the primary groundwater COC is TCE. This contaminant is a halogenated organic compound used by industry for a variety of purposes. It mainly was used as a degreasing and cleaning agent on-site. EPA has set the MCL for drinking water at 5 ppb, and the American Conference of Governmental Industrial Hygienists (ACGIH) has the 8-hour time weighted average at 10 ppm. TCE is a nonflammable, colorless liquid that has a sweet odor and a sweet burning taste. Historically, TCE was used as a solvent to clean equipment. It is heavier than water and has low solubility (up to one part TCE per thousand parts of water at room temperature). TCE in high concentrations may take on a liquid form commonly referred to as DNAPL and in the presence of water forms a separate phase from the water. These qualities make TCE a difficult contaminant to remediate. When present in groundwater, TCE tends to settle into a layer at the bottom of the aquifer and then continuously dissolves into the groundwater. TCE no longer is used at the Paducah Site.

Breathing small amounts of TCE may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage. Drinking large amounts of TCE may cause nausea, liver damage, unconsciousness, impaired heart function, or death. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Skin contact with TCE for short periods may cause skin rashes. In its 12th Edition of the Report on Carcinogens, the National Toxicology Program determined that TCE is "reasonably anticipated to be a human carcinogen." The International Agency for Research on Cancer has determined that TCE is a "probably carcinogenic to humans (Group 2A)."

1,2-DCE, *cis*- and *trans*-. 1,2- DCE is a degradation product of TCE. It exists in two isomeric forms, *cis*-1,2-DCE and *trans*-1,2-DCE. Although not utilized extensively in industry, 1,2-DCE is used both in the

production of other chlorinated solvents and as a solvent. Humans are exposed to 1,2-DCE primarily by inhalation, but exposure also can occur by oral and dermal routes. Information on the toxicity of 1,2-DCE in humans and animals is limited. Studies suggest that the liver is the primary target organ. EPA does not classify 1,2-DCE as a human carcinogen.

Vinyl Chloride. Vinyl chloride (VC) is a degradation product of TCE. It is also a halogenated organic compound and is used in industry as an intermediary of polyvinyl chloride (PVC) and other chlorinated compounds. VC has not been used in the PGDP manufacturing processes. Exposure to VC has been associated with narcosis and anesthesia (at very high concentrations), liver damage, skin disorders, vascular and blood disorders, and abnormalities in central nervous system and lung function. Liver cancer is the most common type of cancer linked with VC, a known human carcinogen. Other cancers related to exposure include those of the lung, brain, blood, and digestive tract.

1,1-DCE. 1,1-DCE is used primarily in the production of PVC copolymers and as an intermediate for synthesis of organic chemicals. Acute exposure to 1,1-DCE has been associated with central nervous system depression, which may progress to unconsciousness. 1,1-DCE is irritating when applied to the skin, and prolonged contact can cause first-degree burns. Direct contact with the eyes may cause conjunctivitis and transient corneal injury. EPA has classified 1,1-DCE as a possible human carcinogen.

Tc-99. Tc-99 is a fission product and is a long-lived, low-energy, beta-emitting radionuclide and is a potential hazard, especially in the groundwater plume. Tc-99 is a light element that is very mobile, bonds to protein, and usually cannot be easily removed, especially from hair. Like most radionuclides, it is harmful if taken internally although the beta particles it emits are very weak. The potential for personnel exposure is limited and controls are implemented through the procedures, work instructions, RWPs, and JHAs.

Table 4. Chemical Exposure and Hazard Information

Substance	Odor	PEL	Route	Symptoms of Exposure	Treatment
Carbon monoxide	Odorless	25 ppm	Inhalation	Headache; nausea; weakness; dizziness; confusion; hallucinations; angina; coma; death	Eye: Immediate medical attention Skin: Immediate medical attention Breath: Respiratory support
TCE	Characteristic aromatic	10 ppm	Inhalation, Ingestion, Contact	Eye, skin, and mucous membrane irritation; dermatitis; headache; fatigue; dizziness; confusion	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
1,2-DCE (*cis-, trans-)*	Acrid, chloroform	200 ppm	Inhalation, Ingestion, Contact	Eye, skin, and throat irritation; headache; fatigue; central nervous system depression; liver and kidney damage	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention

Table 4. Chemical Exposure and Hazard Information (Continued)

Substance	Odor	PEL	Route	Symptoms of Exposure	Treatment
1,1-DCE	Mild, sweet, chloroform	5 ppm	Inhalation, Ingestion, Contact	Eye, skin and throat irritation; dizziness; headache; fatigue; central nervous system depression; liver and kidney damage	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
VC	Pleasant- at high concentration	1 ppm	Inhalation, Ingestion, Contact	Eye, skin and throat irritation; dizziness; headache; fatigue; central nervous system depression; liver and kidney damage	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
Compressed nitrogen (simple asphyxiant)	Gas	N/A	Inhalation, Contact	Headache; nausea; weakness; dizziness; confusion; difficulty breathing	Breath: Respiratory support, oxygen, immediate medical attention
Diesel fuel	Oily	100 mg/m³	Inhalation, Ingestion, Contact	Burning sensation in chest; headache; nausea; weakness; restlessness; incoherence; confusion; drowsiness; diarrhea; dermatitis	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
Diesel exhaust (carcinogenic)	Varies upon exhaust components	CO 25 ppm	Inhalation	Eye irritation; pulmonary function changes	Breath: Respiratory support
Gasoline, (carcinogenic, benzene)	Characteristic aromatic	300 ppm	Inhalation, Ingestion, Contact	Eye, skin, and mucous membrane irritation; dermatitis; headache; fatigue; dizziness; confusion	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
Silica, crystalline (as respirable dust)	Colorless, odorless solid	0.025 mg/m³	Inhalation, Ingestion, Contact	Cough; breathing difficulty; wheezing; decreased pulmonary function; progressive respiratory symptoms (silicosis); irritation eyes	Eye: Irrigate immediately Skin: Soap wash daily Breath: Respiratory support Swallow: Immediate medical attention

Table 4. Chemical Exposure and Hazard Information (Continued)

Substance	Odor	PEL	Route	Symptoms of Exposure	Treatment
Hydrochloric acid Sulfuric acid Nitric acid	Vapors	5 ppm 0.2 mg/m³ 2 ppm	Inhalation, Ingestion, Contact	Irritated eyes, nose and throat, larynx; cough, choking; dermatitis; skin burns; pulmonary edema	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention
Tc-99	N/A	Set by 10 *CFR* Part 835	Inhalation, Ingestion	Cancer	If contact suspected, notify radiological control (RADCON) immediately

7.10 SUSPECTED BIOLOGICAL HAZARDS

Biological hazards that may be present at the site include snakes; insects, such as ticks; and poisonous plants, such as poison ivy, oak, or sumac. Personnel should be aware of the presence of potential hazards and prevent insects and ticks with repellant and avoid hazards as much as possible. Personnel who are or may be hypersensitive to plants and insects stings should report their condition to the Frontline Supervisor, Field Team Manager, or designee and IS/IH specialist.

7.11 SUSPECTED PHYSICAL/CONSTRUCTION HAZARDS

The physical hazards discussed in the sections that follow have been identified as potential hazards for activities and/or tasks that will be required during the work activities. Strict adherence to standard work practices and the DOE prime contractor's procedures will aid in the elimination or control of these hazards.

7.11.1 Noise

Saws, generators, compressors, and other equipment may produce noise exceeding 85 decibels. Sound levels will be assessed and/or measurements will be taken for specific equipment and tasks, and project personnel will be made aware of the hearing protection requirements. Noise assessment, prevention, and protection will be in accordance with procedure CP2-HS-2002, *Occupational Noise Exposure and Hearing Conservation Program*.

7.11.2 Pinch/Compression Points

Pinch and compression points associated with drilling, sampling, and other equipment may result in injury to personnel. All equipment must be maintained in proper working order, with all protective shields or guards in place. Any equipment found to be lacking in these areas will be removed from service per procedure CP3-HS-2008, *Accident Prevention/Equipment Control Tags.* Any activity with the potential for pinch/compression point hazards will be identified during work planning, and work controls will be put in place to mitigate those hazards.

7.11.3 Traffic and Heavy Equipment

The work locations will be at or near roads, fueling stations, building entrances, deactivation contractor work areas, and cylinder storage areas. These locations may be traveled heavily by plant traffic and cylinder haulers, which pose hazards to personnel working in and around the work area. Coordination with other DOE subcontractors and the DOE prime contractor and special precautions should be taken to reduce the amount of traffic around the work zone. If the DOE prime contractor is performing work in close vicinity of the work area with equipment, DOE prime contractor personnel shall pause work until the area is clear. These conditions pose hazards to personnel and must be respected; personnel must remember that cylinder haulers have the right-of-way on plant roads. Personnel working in the area of traffic and/or heavy equipment shall wear a high visibility shirt, vest, or jacket. Also, personnel walking on the plant site shall walk only on designated sidewalks. Many areas of the plant have limited sidewalks, so personnel shall be diligent to identify pathways that pose the least hazard.

7.11.4 Steam and High-Pressure Cleaning Equipment

Decontamination of equipment may require the use of steam and high-pressure cleaning. Project personnel performing decontamination activities will do so in accordance with CP4-ER-2701, *Large Equipment Decontamination*, the task-specific JHA, and/or work control documents. Personnel will be knowledgeable of the use and hazards associated with the equipment and utilize appropriate PPE. Personnel using this equipment will, at a minimum, wear the following PPE: ANSI-approved safety glasses, face shield, hard hat, steel-toe boots, and disposable latex or nitrile gloves. Additional PPE may be required for radiological protection. Any proposed variation from the prescribed PPE requirements must be approved by the IS/IH specialist and Frontline Supervisor, Field Team Manager, or designee before implementing the change. Personnel should be aware that PPE and decontamination solutions may present an environmental hazard, and should be managed in a manner to prevent mixing with other wastes/materials.

7.11.5 Repetitive Motion

Activities involving potential hazards associated with repetitive motion, such as shoveling or sampling activities, will be addressed in task-specific JHAs and/or work control documents. Awareness and controls, such as taking frequent breaks, utilizing worker rotation, and position modification, will be covered with affected personnel during prejob and daily meetings as needed.

7.12 NUCLEAR CRITICALITY SAFETY HAZARDS

Nuclear criticality safety (NCS) hazards are evaluated in accordance with the DOE prime contractor's procedure CP2-NS-1000, *Nuclear Criticality Safety Program Description Document at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. NCS controls must be implemented for all items that contain or potentially contain fissile material in order to prevent the occurrence of an inadvertent nuclear criticality. An accidental criticality is an extremely rare event, usually of very short time duration, and normally is self-limiting. Even though the time duration of a criticality is short, the radiation produced can be very intense. Criticalities are detected through the use of a Criticality Accident Alarm System (CAAS). When a CAAS alarm is activated, all personnel are to flee the immediate evacuation zone via the most direct route and report to the closest plant assembly point.

7.13 ENVIRONMENTAL MANAGEMENT SYSTEM HAZARDS

The EMS hazards discussed in the sections that follow have been identified as potential impacts for activities and/or tasks that will be required during the work activities. Strict adherence to standard work practices and the DOE prime contractor's procedures will aid in the elimination or control of these hazards.

7.13.1 Waste Generation/Waste Minimization

Personnel will minimize the wastes generated during drilling and sampling activities. They will segregate, store, manage, and recycle/dispose of wastes properly, as provided in CP2-WM-0001, *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan*, and CP2-ES-0005, *Pollution Prevention/Waste Minimization Plan for the Deactivation and Remediation Project, Paducah Gaseous Diffusion Plant, Paducah, Kentucky.*

7.13.2 Spills/Releases to the Environment

Personnel will use caution when drilling to prevent the uncontrolled release of drill cutting and contaminated groundwater to the environment. Care should be taken during handling samples, preservatives, and other hazardous materials/contaminants to prevent spills/releases to the environment and provide timely response if a spill/release should occur. Work controls (applicable JHAs, the work package, and other applicable work control and project-related documents) will be developed identifying hazards and mitigation controls.

7.14 TRAINING

As a requirement for work on this project, workers entering the exclusion zone (EZ) or contamination reduction zone (CRZ) will be required to take appropriate HAZWOPER training associated with the tasks and ongoing activities. This training must cover the requirements in 29 *CFR* Part 1910.120. In addition, workers must receive annual 8-hour refresher training (if applicable) and 3-day on-site supervision under a trained, experienced supervisor. Supervisory personnel shall receive additional 8-hour training in hazardous waste operations supervision. Workers and visitors entering the EZ or CRZ will be briefed in the provisions of the HASP and be required to sign the HASP Acknowledgment Form (or equivalent documentation). Workers entering radiological posted work areas also will be required to complete Radiological Worker Training in accordance with CP3-RP-1104, *Radiological Area Entry Control*, and comply with requirements of work control documents.

An example set of core training requirements can be found in Table 5. Specific training requirements will be identified by the project team during work planning.

Table 5. Core Training Requirements

General Employee Training
Rad Worker II
HAZWOPER 40-hour (24-hour, as appropriate)
Current HAZWOPER Medical
HAZWOPER 8-Hour Refresher
3-day HAZWOPER Supervised Field Experience
Worker Safety And Health Program Orientation
Temperature Extremes
Environmental Management System Awareness
Consolidated Annual Training
Employee Conduct Training (DOE prime contractor employees only)

7.15 PERSONAL PROTECTIVE EQUIPMENT

The use of appropriate PPE is required for personnel involved in operations where exposure to hazardous conditions exist and cannot be eliminated by engineering controls or where such equipment is needed to reduce hazards. PPE will be selected and used in accordance with OSHA standards and the requirements of the DOE prime contractor procedures. PPE selection will be determined by IS/IH specialist and RADCON to ensure protection of the workers from site-specific hazards posed by the task and work location.

PPE will be utilized as follows.

- It is not possible and/or feasible to implement engineering controls and work practices that will unequivocally ensure the safety and health of workers.

- It is necessary to reduce and maintain employee exposure less than the applicable PELs in 29 *CFR* Part 1910, Subparts G and Z, and/or less than the applicable reduction zone threshold limit values (TLVs) established by the ACGIH, or in the absence of PELs or TLVs, less than the applicable recommended exposure limits published by the National Institute for Occupational Safety and Health.

- Radiological materials/contamination may be present in excess of levels established by site RADCON criteria.

- Workers may be exposed to chemical contamination through skin absorption.

Existing or potential physical hazards may pose a threat to worker safety and health. Because potential hazards will vary with individual field activities, PPE may be modified for specific tasks. The PPE for each task will be listed on applicable JHAs, work instructions, and/or RWPs.

Initial entry to work areas will include PPE appropriate for the predicted hazards in the work area based on preliminary data. The PPE requirement for subsequent entries into a specific zone will be based upon the information gathered during the initial entries.

Selection of the most appropriate level of protection and combinations of respiratory protection is based on the following:

- Level of knowledge of on-site chemical, biological, and radiological hazards;

- Properties, such as toxicity, radioactivity, route of exposure, and matrix of the contaminants known or suspected of being present;

- Type and measured concentrations of the contaminants that are known or suspected of being present;

- Potential for exposure to contaminants in air, liquids, soils, or by direct contact with hazardous materials;

- Physical hazards; and

- Temperature extremes.

Personnel entering the work zone are required to undergo training for the use of PPE. For routine work, Level D PPE or modified Level D is required. Where the scope of work requires a higher level of PPE, specific training will be provided.

PPE requirements will be identified in the JHA/RWP(s) and/or work instructions and discussed with site workers prior to the start of work. Employees will be trained and approved following baseline medical examinations for the use of prescribed PPE. Radiological PPE requirements will be integrated with those established for potential non radiological contaminants to ensure compatibility prior to the start of work. The following sequential steps must be followed to facilitate the selection of PPE for hazardous waste site operations.

- Identify work area and job-specific hazard potential (e.g., chemical, radiological, physical, mechanical).
- Determine type of exposure for the work areas and specific work activities.
- Determine level of respiratory protection for the work areas and specific work activities, including cartridge selection, if appropriate.
- Evaluate the chemical resistant characteristics needed for the potential exposures and select clothing with the appropriate protection factor, evaluate potential physical hazards associated with the work areas and specific work activities (e.g., walking/working surfaces, electrical installations/lines, noise exposure), and select PPE to mitigate identified hazards.
- Consider climatic conditions and select PPE to accommodate the conditions (e.g., cooling units, insulated clothing/footwear).
- Evaluate potential biological hazards (e.g., snakes, insects) and select PPE to mitigate identified hazards.
- Evaluate type and level of work (e.g., heavy, moderate, light) and select PPE for the work.
- Evaluate PPE for both chemical and radiological hazards when mixed waste is involved.

The specific levels of PPE and necessary components for each level are divided into four categories according to the degree of protection afforded. The following are general guidelines to use to identify level of PPE.

Level A: Worn when the highest level of respiratory, skin, and eye protection is needed.

Level B: Worn when the highest level of respiratory protection is needed, but a lesser level of skin protection is needed.

Level C: Worn when the criteria for using air-purifying respirators are met, but a lesser level of skin protection is needed, and oxygen concentrations are between 19.5% and 23%.

Level D: Refers to work conducted without respiratory protection. This level should be used only when the atmosphere contains no known or suspected airborne chemical or radiological contaminants and oxygen concentrations are between 19.5% and 23%.

Health and Safety Supplies and Equipment. A sufficient quantity of drinking water or replacement fluids shall be maintained at the site. In addition, a hand-wash area will be made available, and all personnel are

encouraged to wash their hands prior to eating, drinking, tobacco use, and at the conclusion of each day's work activities.

Eyewash stations will be available as necessary and will operate in accordance with manufacturer specifications. An eyewash solution with an antimicrobial agent will be used in accordance with the schedule specified by the manufacturer.

Safety equipment shall be inspected for serviceability by the DOE prime contractor's project personnel, initially at the start of the project and periodically thereafter. Any defective equipment will be taken out of service immediately, tagged, and replaced. In addition to periodic inspections, the presence of compliant, operable extinguisher and first aid kit shall be verified by field personnel prior to the start of work and inspected in accordance with procedures and regulations. Safety equipment inspections shall be documented on equipment tags or in the project records.

7.16 MEDICAL SURVEILLANCE

The medical surveillance program provides for baseline, annual, and termination medical examinations for site employees in accordance with 29 *CFR* Part 1910.120, *Hazardous Waste Operations and Emergency Response,* and DOE prime contractor procedure CP3-HS-4002, *Implementation of the Occupational Medicine Program*.

Personnel performing HAZWOPER activities on this project must complete an annual HAZWOPER physical. The examining physician will document the worker's fitness for work and ability to wear a respirator, as applicable.

Radiation workers, working under an RWP, may be required to submit a baseline bioassay, periodic bioassay during the project, and exit bioassay at the end of the project. Detailed explanation of the radiation worker requirements are described in CP2-RP-0001, *Four Rivers Nuclear Partnership, LLC, Radiation Protection Program for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky.*

7.17 EXPOSURE MONITORING

Exposure monitoring at the worksite shall be done in accordance with CP4-HS-2000, *Industrial Hygiene Sampling*, and applicable subcontract requirements. This will be done to evaluate the effectiveness of engineered controls, to confirm appropriate PPE/respirator selection, and to assess employee exposures. Exposure monitoring shall be conducted pursuant to requirements of 29 *CFR* Part 1910.120. Requirements for radiological monitoring are contained in the DOE prime contractor Radiation Protection Program. All equipment will be maintained and calibrated per the manufacturer instructions.

Worker exposure monitoring and sampling shall be determined by IH on a case-by-case basis. Information gathered during initial assessments shall be used to determine the PPE requirements. Information gathered in subsequent assessments shall be used to modify exposure monitoring as necessary to ensure worker safety and health and protection of the environment. General monitoring criteria are defined in the following subsections.

7.17.1 Employee Nonradiological Exposure Monitoring

Depending on the work activities being performed, real-time and/or integrated personal exposure sampling will be performed where there is a potential for employees to be overexposed. Exposure action levels shall

be established for contaminants to which employees reasonably may be exposed. These action levels shall be developed based on regulatory drivers, industry standards, and sound IH practice. Exposure monitoring data may be used to evaluate the effectiveness of engineering and administrative controls, as well as to upgrade or downgrade PPE requirements.

The monitoring frequency and coverage may be increased should monitoring data indicate the potential for exposure to higher concentrations of chemicals than initially anticipated or if changes in the scope of work involve potential exposure to particularly toxic chemicals.

7.17.2 Environmental Air Monitoring

The expectation of significant contaminants becoming airborne and potentially dispersing is minimal. IH may initiate project boundary or perimeter monitoring as necessary to ensure protection of the public and the environment. The goal of such monitoring will be to determine whether any airborne contaminants are dispersing from the designated work area and to obtain data that would identify the need for corrective action in the work area.

7.18 TEMPERATURE EXTREMES

Typically, one of the most common types of stress that affects field personnel is from heat and cold. Heat stress and cold stress are serious hazards to workers at waste sites. Personnel will be familiarized with the symptoms of heat and cold stress during training or in the plan-of-the-day/prejob briefing. Activities related to heat and cold stress and work rest activities will be performed in accordance with the DOE prime contractor's procedure CP3-HS-2000, *Temperature Extremes*.

Cool water and disposable drinking cups or bottled water will be provided in a rest area and/or break trailer. Workers shall use safe work practices, including drinking plenty of fluids, such as water, taking rest breaks as necessary, and using the "buddy system" to monitor one another and watch for heat or cold stress symptoms.

7.18.1 Heat Stress

Heat stress is a condition that arises from a variety of factors, among the most important of these is ambient temperature, the relative humidity, the level of effort required by the job, and the clothing being worn by an exposed individual. An individual who is experiencing heat stress will tend to exhibit an array of measurable symptoms that can include an increased pulse rate, a greater rate of perspiration (except for heat stroke), and an increase in the individual's body temperature.

Heat-related disorders generally are classified as one of the following four basic categories.

- Heat Rash—Caused by continuous exposure to heat or humid air and can be recognized by the occurrence of small red pimples on the skin. Typically found in sensitive areas of the body where the potential for rubbing can occur (e.g., underarm, groin area).

- Heat Cramps—Caused by heavy sweating and inadequate electrolyte replacement. Signs to look for include muscle spasms and pain in the extremities, such as hands and feet, and in the abdomen.

- Heat Exhaustion—Caused by increased stress on various parts of the body, including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs to look for include the following:

— Pale, cool, moist skin,
— Heavy sweating,
— Dizziness,
— Nausea, and
— Fainting.

- Heat Stroke—This is the most serious of all temperature related disorders or conditions since temperature regulation fails and the body temperature rises to critical levels. Immediate action should be taken to cool the body before serious injury or death occurs. Competent medical help should be obtained. Signs to look for include the following:

  — Red, hot, usually dry skin;
  — Lack of or reduced perspiration;
  — Nausea;
  — Dizziness and confusion; and
  — Coma, in extreme situations.

A number of steps can be taken to minimize the potential for heat stress disorders.

- Acclimate employees to working conditions by increasing workloads slowly over extended periods of time. Do not initiate site work activities with tasks having the most demanding physical expenditures.

- As practicable, conduct strenuous activities during cooler portions of the day, such as early morning or early evening.

- Provide employees with lots of water and/or electrolytes and encourage them to drink it throughout the work shift; discourage the use of alcohol and caffeine during nonworking hours as these contribute to dehydration. It is essential that fluids lost through perspiration be replenished.

- During hot periods, rotate out employees wearing impervious clothing.

- Provide cooling devices, as appropriate. Mobile showers and/or hose-down facilities, powered air purifying respirators, and ice vests all have proven effective in helping prevent heat stress.

- Provide shade, hats, and sunscreen, when possible. Sunburn reduces the skin's ability to release excess heat, making the body more susceptible to heat-related illness. Repeated overexposure to sunlight also leads to skin cancer.

7.18.2 Cold Stress

Persons working outdoors in low temperatures, especially at or below freezing, are subject to cold stress disorders. Exposure to extreme cold for even a short period of time can cause severe injury to the body surfaces and/or profound cooling, which can lead to death. Areas of the body that have high surface area-to-volume ratios, such as fingers, toes, and ears, are the most susceptible. Two basic types of cold disorders exist: localized (e.g., frostbite) and generalized (e.g., hypothermia). The descriptions for frostbite and hypothermia are provided below.

Frostbite can occur, in absence of hypothermia, when the extremities do not receive sufficient heat from central body stores. This can occur because of inadequate circulation and/or insulation. Frostbite occurs when there is freezing of fluids around the cells of the body tissues due to extremely low temperatures.

Damage may result, including loss of tissue around the areas of the nose, cheeks, ears, fingers, and toes. This damage can be serious enough to require amputation or result in permanent loss of movement.

Hypothermia is described as when the temperature of the body drops. The first symptoms of this condition are uncontrollable shivering and the sensation of cold, irregular heartbeat, weakened pulse, and change in blood pressure. Severe shaking of rigid muscles may be caused by a burst of body energy and changes in the body's chemistry. Vague or slow, slurred speech, memory lapses, incoherence, and drowsiness are some of the additional symptoms. Symptoms noticed before complete collapse are cool skin, slow and irregular breathing, low blood pressure, apparent exhaustion, and fatigue even after rest. As the core body temperature drops, the victim may become listless and confused, and may make little or no attempt to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. If the body core temperature drops to about 85°F, a significant and dangerous drop in the blood pressure, pulse rate, and respiration can occur. In extreme cases, death will occur.

A number of steps can be taken to minimize the potential for cold stress.

Individuals can achieve a certain degree of acclimation when working in cold environments as they can for warm environments. The body will undergo some changes that increase the body's comfort and reduce the risk of cold injury.

Working in cold environments causes significant water losses through the skin and the lungs as a result of the dryness of the air. Increased fluid intake is essential to prevent dehydration, which affects the flow of blood to the extremities and increases the risk of cold injury. The skin should NOT be exposed continuously to subzero temperatures.

7.19 SITE CONTROL

7.19.1 Background

The site control program at hazardous waste sites is used to control the activities and movement of people and equipment in order to minimize the potential for worker exposure to hazardous substances. The provisions of 29 *CFR* Part 1910.120(d) require that an appropriate site control program be developed prior to the implementation of cleanup operations.

Site control for field activities will be determined by the Frontline Supervisor, Field Team Manager, or designee, IS/IH specialist, and RADCON and will be communicated to the workers through prejob briefings. Site control may be modified as new information becomes available based on the types of hazards that are found.

During the performance of this project, a Radiological Area generally will equate to an EZ (hot zone), a Radiological Buffer Area generally will equate to a CRZ (warm zone), and a Controlled or Clean Area generally will equate to a support zone (cold zone).

The overall objective of the site control component of the HASP is to specify procedures to minimize employee exposure and protect the public from hazardous substances and to prevent unauthorized access to the site.

7.19.2 Visitors

Visitors requesting to observe work conducted in the work area must wear appropriate PPE prior to entry into the area. Visitors are nonworkers who are on the site occasionally, for a specific or limited task, such as observing work activities. Visitors who wish to enter a HAZWOPER EZ must produce evidence that they have had medical clearance, which includes complete physical examination for hazardous waste operations, appropriate HAZWOPER training, and subsequent 8-hour refresher training. Visitors also must have received the required training for the tasks being performed and entry must be approved by the Frontline Supervisor, Field Team Manager or designee, IS/IH specialist, and/or RADCON.

7.19.3 Zone Delineation

During the SWMU 211-A RA execution, areas where activities involve contact with uncharacterized material or performance of activities that may pose a risk of overexposure above the established action levels will be considered the EZ. The Boundary Control Station areas, as applicable, will be considered the CRZ, and areas outside of the work area will be the support zone.

7.19.4 Using the Buddy System

When performing activities in remote areas, workers must use the "buddy system" to ensure that rapid assistance can be provided in the event of an emergency. The buddy system is an approach used to organize work groups so that each worker is observed by at least one other worker. All personnel are responsible for ensuring that the buddy system is incorporated.

As part of the buddy system, workers should remain in close proximity and maintain visual contact with each other to provide assistance in the event of an emergency, and if it is safe to do so. The responsibilities of workers utilizing the buddy system include the following:

- Providing his/her partner with assistance, if it is safe to do so,
- Observing his or her partner for signs of chemical or heat exposure,
- Periodically checking the integrity of his or her partner's PPE, and
- Notifying the Frontline Supervisor or other site personnel if emergency assistance is needed.

7.19.5 Communication Network

Communication systems shall be established for both internal and external communication. Internal communication refers to communication among workers operating within the individual work areas of the site. Routine checks to verify proper operation should be addressed.

External communication refers to communication between on-site and off-site personnel. The primary means of external communication are cellular telephone and radio. An external communication system should be maintained in order to accomplish the following:

- Coordinate emergency response efforts with off-site responders,
- Report progress or problems to management, and
- Maintain contact with essential off-site personnel.

7.19.6 Worker Safety Procedures

As part of site control, procedures have been established to ensure worker safety. Safe work practices are incorporated into standard operating procedures and work control documents, such as work packages, work

instructions, and JHAs. Engineering controls and safe work practices will be implemented to attempt to reduce and maintain employee exposure levels at or below the PELs and published exposure limits for those hazardous substances at the site. Containers with remediation wastes will be stored on-site in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) storage areas (e.g., C-752-C) set up by Waste Generator Services Group in accordance with CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*, and/or Resource Conservation and Recovery Act (RCRA)-permitted storage units located at the Paducah Site. PPE will be used to protect employees against possible exposure to hazardous substances when engineering controls and safe work practices are insufficient to maintain worker exposure at levels below established action levels.

7.20 DECONTAMINATION

Contamination of personnel, equipment, and/or material can occur from contact with radiological and/or hazardous material. When decontamination is required, appropriate procedures shall be followed to ensure effective decontamination is achieved and to minimize generation of mixed waste. The following are overall objectives of decontamination:

- To determine and implement the decontamination methods for personnel and equipment that are effective for the specific hazardous/radioactive substance(s) present;
- To ensure the decontamination procedure itself does not pose any additional safety or health hazards;
- To provide pertinent information on the locations and layouts of decontamination stations and equipment;
- To establish procedures for the collection, storage, and disposal of clothing and equipment that has not been completely decontaminated; and
- To provide for periodic evaluation of the effectiveness of decontamination methods.

7.20.1 General Consideration

It is assumed that some of contamination concerns from the field activities will be radiological in nature. Disposable PPE and one-time use items may undergo radiological surveys prior to release for disposal as nonradioactive waste. Reusable equipment may be required to undergo a radiological survey prior to release from a radiological area. If hazardous waste is encountered, IS/IH specialist and RADCON will assist project management in determining additional methods of decontamination. If clothing or equipment is contaminated with both radiological and hazardous material, mixed waste may be generated. Special precautions shall be taken to ensure this waste is handled, treated, stored, and disposed of properly.

7.20.2 Personnel Decontamination Methods

Personnel decontamination will be conducted in accordance with procedure CP4-RP-1103, *Personnel and Personal Effects Decontamination*. In the event of a chemical exposure, decontamination will be performed according to the available Safety Data Sheet or as directed by IS/IH specialist. After the initial field decontamination, the potentially exposed employee will be transported to the appropriate medical facility for exposure assessment, if deemed necessary by IS/IH specialist.

7.20.3 Collection, Storage, and Disposal Procedures

All items (including clothing, equipment, liquids) that cannot be completely decontaminated shall be considered radioactive, hazardous, or mixed waste, as appropriate. Clothing and equipment shall be collected, treated, stored, and disposed of based on the type and level of contamination according to applicable federal, state, and local regulations. Drainage and/or collection systems for contaminated liquids shall be established and approved containers shall be used. Wash water shall be collected for proper disposal. Waste minimization will be encouraged; however, worker safety and health will take precedence.

7.21 EMERGENCY RESPONSE

The HASP applies to hazards expected to be encountered during work associated with the SWMU 211-A RA that will be conducted at the Paducah Site and personnel need to be familiar with the appropriate action in case an emergency occurs on-site. DOE prime contractor and subcontractor employees are subject to certain requirements of the Paducah Site Emergency Plan and emergency implementing procedures, maintained by the deactivation contractor, in addition to requirements identified in CP3-EP-1023, *Security Emergencies*. Emergency response at the Paducah Site is controlled by the deactivation contractor PSS and appropriate notifications must be made in accordance with the plans and protocols. The following information is guidance in the responsibilities and protocols to follow in case of an emergency at the Paducah Site. Local emergency shelters and assembly points for specific work areas will be identified in work packages/JHAs and communicated to affected personnel.

7.21.1 Responsibilities

The Frontline Supervisor, Field Team Manager or designee, and IS/IH specialist are responsible for the emergency response and communications to appropriate responders.

DOE prime contractor project personnel are responsible for reporting emergencies immediately and ensuring that the appropriate emergency response equipment is readily available at the work site and in proper working order. Depending on the activities and hazards, the following are equipment and supplies to be maintained.

- First-aid kit
- Absorbents for spill control
- Emergency eyewash station/emergency shower
- Fire extinguisher

7.21.2 Reporting an Emergency

7.21.2.1 Discovery of an Emergency

The person who discovers an emergency immediately should attempt to establish control ONLY if the incident is minor in magnitude (e.g., using a fire extinguisher to put out an incipient fire if trained to do so and extinguishment can be accomplished in a safe manner). Where such measures obviously are inadequate or not successful in controlling the incident or for emergency conditions, personal injuries, or other unusual events with potential for causing personal injury, environmental releases, or property damage, the employee will notify the following appropriate emergency response personnel.

- DOE prime contractor response personnel
- The PSS

7.21.2.2 Emergency contacts

Fire: Fire alarm pull box, plant telephone Bell System 333, or plant radio channel 16
Medical: Plant telephone Bell System 333 or plant radio channel 16
Security: Plant telephone Bell System 6246 or plant radio channel 16
PSS:

- Plant telephone Bell System in an emergency—333
- Plant telephone Bell System in non-emergency—6211
- Plant radio channel 16—Alpha 1
- Cell phone in an emergency—270-441-6333
- Cell phone in a non-emergency—270-441-6211

7.21.2.3 Initial emergency response

When an emergency occurs, someone must assume responsibility for the management of the scene and the protection of personnel. Personnel are to be evacuated from the immediate danger area, as appropriate. Initially, this is the person who discovers the emergency, until the arrival of emergency response personnel. For personnel injury or illness, the DOE prime contractor will ensure that at least one person with current training in first aid and cardiopulmonary resuscitation is present on-site during all field activities. This individual will provide minor first aid until other emergency personnel arrive and assume emergency response duties or it is determined to transport the injured to the hospital or the DOE prime contractor's medical provider. Determinations and incident reporting will be made according to DOE prime contractor procedure, CP3-OP-2024, *Initial Incident/Event Reporting.*

7.21.2.4 Emergency response

Fire: Fire response is provided by the DOE prime contractor fire services (or successors) as first responder. The Paducah Site also has mutual aid agreements with additional fire departments, if needed.

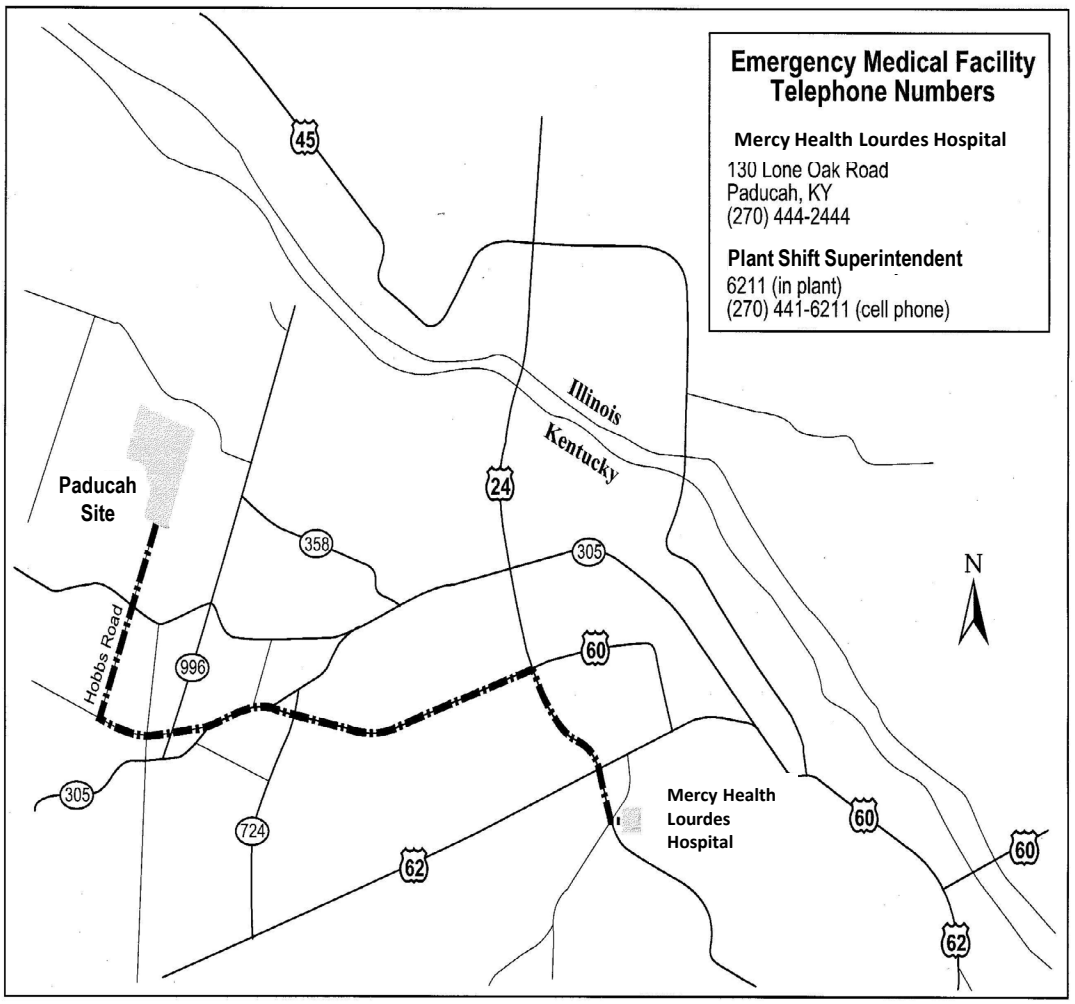
Medical: DOE prime contractor medical service (or successors) is the primary responder in all life threatening and/or potentially serious injuries. Minor injuries should be monitored by first aid or first responder trained personnel and the injured taken to the local hospitals or the DOE prime contractor's medical provider. Maps to both of the local hospitals are provided in Figures 7 and 8.

Security: The DOE prime contractor's security organization/department is responsible to ensure that order is maintained. Agreements exist among the local law enforcement agencies in situations where mutual aid and services may be rendered on the DOE Reservation.

7.21.2.5 Paducah Gaseous Diffusion Plant alarms

The following alarms can be heard by calling 6161 on a Bell phone.

Radiation Emergency/CAAS:	Continuous blast on a high-pitched air whistle or electronic horn ACTION: Evacuate area immediately and stay away from effected building. Report to an assigned plant assembly point. If work area is outside the affected areas, personnel should pause work and listen for plant announcement.



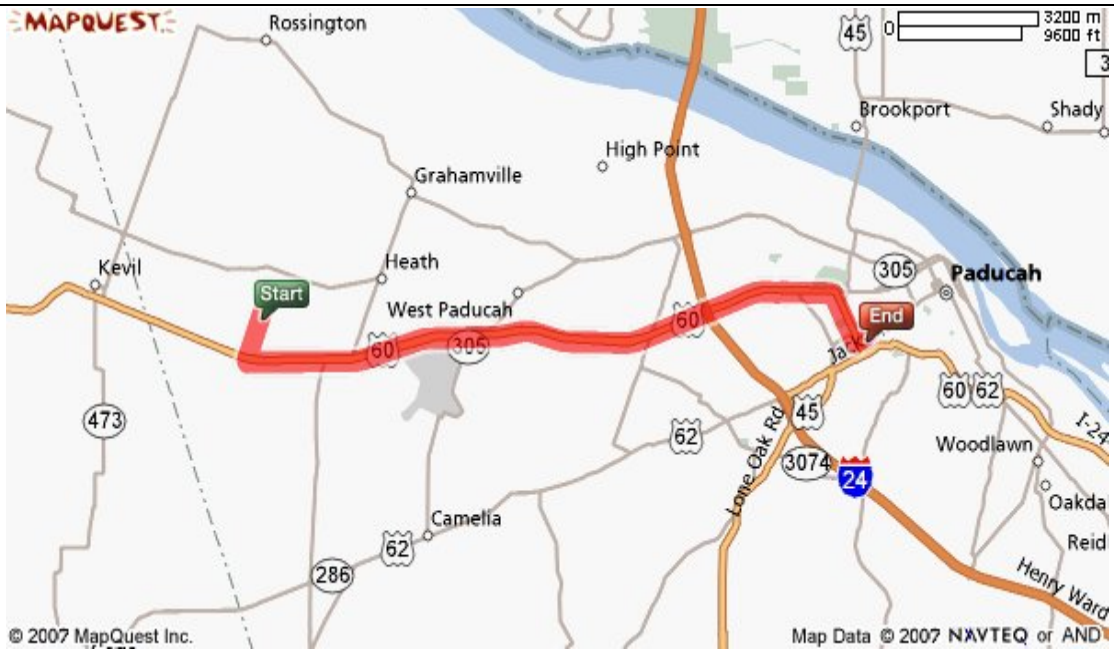
The primary emergency medical facility inside the plant is the C-102 Medical Facility (connected to the C-100 Building).

DIRECTIONS TO MERCY HEALTH LOURDES HOSPITAL

1530 Lone Oak Road, Paducah, Kentucky 42003 (270) 444-2444

From the site go to Highway 60 and travel east into Paducah to I-24. Take I-24 west to Exit 7. Proceed through one traffic light (Hwy. 62) and turn left (going north) at the traffic light onto Hwy. 45. Proceed north approximately 0.25 mile and turn right into Lourdes Hospital. The emergency room is located 0.10 mile (approximately) on the right side.

Figure 7. Map to Mercy Regional Health



DIRECTIONS TO BAPTIST HEALTH PADUCAH

2501 Kentucky Avenue, Paducah, KY 42003 (270) 575-2100

Start out going south on Hobbs Rd/Hwy. 1154. Turn left onto Hwy. 60 east, go 11.1 miles, then turn right in front of Bob Noble Park onto Hwy. 60/Joe Clifton Drive. Continue to follow Hwy. 60/Joe Clifton Drive approximately 0.9 mile, then turn left onto Washington St/Hwy. 45 BR. Continue approximately 0.2 miles to hospital on left.

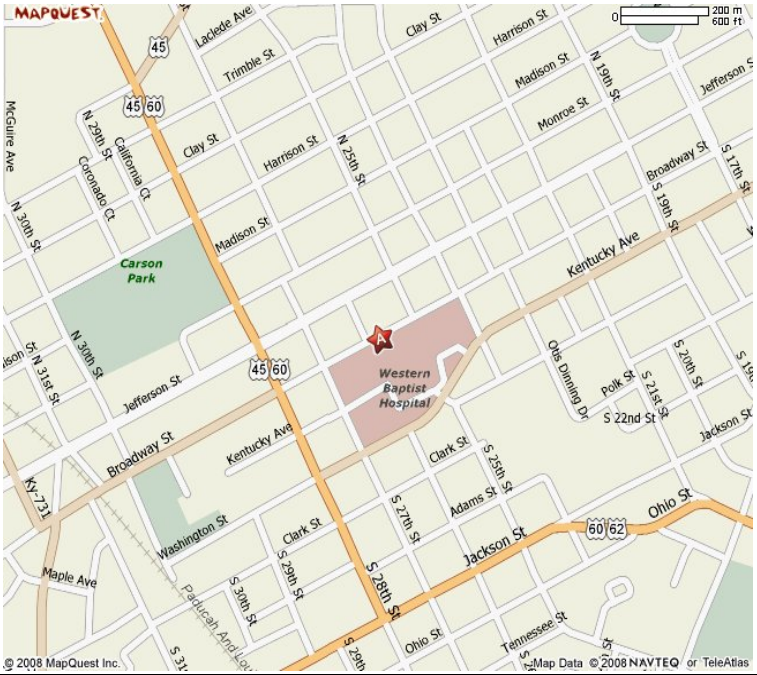


Figure 8. Map to Baptist Health Paducah

Attack Warning/Tornado Warning:	Intermittent 2-second blast on plant horns ACTION: Take cover.
Evacuate Signal:	Continuous blast on plant horns ACTION: Evacuate building and report to an assigned plant assembly point. If work area is outside the affected areas, personnel should pause work and listen for plant announcement.
Plant Emergency:	Hi-lo tones ACTION: Listen to plant public address (PA) system/radio for instructions.
Cascade Buildings:	Three blasts on building horns or howlers ACTION: Call area control room.
Other Buildings:	One 10-second blast on building horns or sirens ACTION: Follow local emergency procedures.

7.21.3 Fire

7.21.3.1 Definitions

Incipient Stage Fire. A fire that is in the initial or beginning stage and that can be controlled or extinguished by a portable fire extinguisher, Class II standpipe, or small hose systems without the need for protective clothing or breathing apparatus.

Hostile Fire. An unwanted or destructive fire.

7.21.3.2 Reporting a fire

Persons observing a hostile fire should report it immediately by pulling the nearest fire alarm box, phoning Bell 333, or using channel 16 on the radio.

Persons reporting a fire should remain near the area to direct emergency responders if it is safe to do so. Persons reporting the fire should also ensure the areas near the fire have been evacuated and that all personnel have been directed to a remote location upwind of the fire.

Use fire extinguishers to put out an incipient fire if trained to do so and if extinguishment can be accomplished in a safe manner.

7.21.3.3 Protective actions for fire

Personnel should evacuate the area and proceed to the designated assembly points.

Listen for an announcement or emergency instructions from the DOE prime contractor incident commander or other emergency response officials. Depending on the nature and extent of the emergency, an assembly point may be provided in the emergency instructions.

For local accountability purposes, report to the Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist who then will contact the DOE prime contractor's project management.

The Frontline Supervisor, Field Team Manager or designee, and IS/IH specialist organization have the following responsibilities:

- Checking their assigned areas, if it is safe to do so, to assist with the evacuation and ensure the areas are clear;
- Reporting to the designated assembly point and begin organizing the local accountability;
- Sizing up the fire;
- Ensuring the alarm has been reported to the PSS; and
- Using fire extinguishers to put out an incipient fire if trained to do so and if extinguishment can be accomplished in a safe manner.

7.21.4 Tornado/Severe weather

7.21.4.1 Definitions

Tornadoes. A tornado is formed by winds rotating at very high speeds typically in a counterclockwise direction. A typical tornado in the Paducah Site area, with wind speeds of 73 to 112 mph, moves from the southwest to the northeast following the parent thunderstorm. A tornado can move in any direction and can change direction at any time. Tornadoes travel at various speeds, usually between 25 and 45 mph, and are usually on the ground less than 10 minutes. The largest tornadoes can produce wind speeds of up to 380 mph and follow a path 1,000-miles long and 10-miles wide.

Severe Thunderstorm. A severe thunderstorm produces wind speeds of up to at least 58 mph or hailstones of up to three-quarters of an inch or larger in diameter. They may produce lightning and, during downbursts, produce straight-line winds of 150 mph or faster.

Lightning. Lightning strikes the earth 40 million times each year. Lightning's return stroke of 50,000°F is hotter than the surface of the sun. Lightning kills more people each year than tornadoes.

Thunderstorm Warning. Issued by the National Weather Service (NWS) to inform residents of a specific area that a severe thunderstorm is moving toward their location.

Thunderstorm Watch. Issued by the NWS to identify a relatively large area in which conditions are favorable for severe storms.

Tornado Warning. A warning issued by the NWS to inform residents of a specific area when a tornado sighting has been confirmed or indicated by radar and is moving toward their location.

Tornado Watch. A watch issued by the NWS to identify a relatively large area in which conditions are favorable for the formation of a tornado.

7.21.4.2 Inclement weather

All field activities shall be paused during thunderstorms or high wind conditions. Personnel will secure equipment and materials in a safe condition and move to the designated assembly point. Plant evacuation assembly points are presented in Facility Emergency Action Plans and will be covered with all personnel as part of the initial site-specific briefing and reviewed, as necessary, during plan-of-the-day/prejob briefings.

7.21.4.3 Reporting severe weather

Immediately report the sighting of a tornado, local flooding, or damage from a storm to the PSS by phoning Bell 333 or channel 16 on the radio.

7.21.4.4 Receiving a severe weather report

Thunderstorm or Tornado Watch. The PSS sounds the hi-lo tone alarm and makes a PA announcement of the watch.

Thunderstorm Warning. The DOE prime contractor PSS sounds the hi-lo tone alarm, makes a PA announcement of the thunderstorm warning, and instructs all personnel in mobile office structures to relocate to a permanent structure.

Tornado Warning. The DOE prime contractor PSS sounds the hi-lo tone alarm, makes a PA announcement of the tornado warning, and sounds the take cover signal over the PA system.

7.21.4.5 Protective actions for severe weather

Thunderstorm or Tornado Watch. No protective action is required. This is merely a caution that conditions may deteriorate. All personnel should stay alert for further updates or warnings.

Thunderstorm Warning. Upon receiving a thunderstorm warning, personnel working in mobile office trailers will be directed to relocate in permanent facilities. Personnel conducting field activities must immediately perform those tasks necessary to stabilize the worksite and proceed to a stable building or relocate to a storm shelter. All personnel should take lightning precautions and expect high winds and damaging hail. The Frontline Supervisor, Field Team Manager or designee, and IS/IH specialist will be responsible for accounting for all project personnel and immediately notifying the PM of any unaccounted-for personnel.

Tornado Warning. Upon receiving a tornado warning, all personnel should take cover in the nearest take cover area.

- **Indoors.** Personnel should take cover in the designated tornado shelter for your locations. Automobiles, trailers, and other mobile structures should be vacated.

- **Outdoors.** If time permits, proceed immediately to a safe shelter. If unable to find shelter, lie flat in the nearest ditch or depression. Stay out of mobile structures, automobiles, or trailers.

7.21.4.6 After a tornado strike

The following actions should be taken following a tornado strike.

- The Frontline Supervisor, Field Team Manager or designee, and IS/IH specialist will take charge of the area.

- After the tornado has passed, the local emergency director should check for personnel injury, look for fires or fire hazards, and be aware of any chemical leaks or releases.

- Take only the emergency action for which you are trained, as directed by procedure.

- Be alert for such dangers as loose electrical and high-voltage wires; damaged structures; and broken or cracked gas lines that may be releasing flammable, toxic, or inert gas. De-energize nonessential electrical equipment to ensure continued operations.

- Stay in the designated assembly area until instructed otherwise.

- Do not reenter any building; there may be damage.

The following are the responsibilities of the Frontline Supervisor and IS/IH specialist.

- Upon receiving direction to relocate, assist by directing local population in their area on relocation areas and desired routes to travel. Assist in organizing the group as they relocate.

- Upon receiving a take cover alarm, the Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist will assist the crew by directing them to the appropriate take cover area. They will assist in organizing the group, maintaining an orderly response action, and keeping the group together.

- After a tornado strike, take charge of the local area, check for personnel injury, look for fires or fire hazards and be aware of any chemical leaks or releases, and initiate the local accountability.

- Look for such dangers as loose electrical or high-voltage wires; damaged structures; and broken or cracked gas lines that may be releasing flammable, toxic, or inert gas. De-energize nonessential electrical equipment to ensure continued operations.

7.21.5 Earthquake

7.21.5.1 Definitions

New Madrid Earthquake Zone. The Paducah Site lies within the New Madrid earthquake zone. Rift zones such as this produce large but infrequent earthquakes. The zone is active and produces thousands of micro earthquakes each year. Persons in the New Madrid earthquake zone can expect earthquakes ranging from minor ground shaking to a catastrophic earthquake. Something in the mid-range can be expected in the next 20 years.

Earthquake. An earthquake is a sudden release of energy that occurs when rock abruptly shifts along a break in the earth's crust.

Aftershocks. Additional shock waves follow the main shock wave of an earthquake. They may be minor or nearly as strong as the initial shock.

7.21.5.2 Reporting an earthquake

There is no need to report a substantial earthquake; everyone will know. Slight ground shaking should be reported to the PSS by phoning Bell 333.

7.21.5.3 Receiving an earthquake alarm

The first alarm you receive concerning an earthquake will be the ground shaking. There is no alarm that can warn you of an approaching earthquake.

7.21.5.4 Protective actions

During the quake

(1) Indoors. If indoors, be alert for falling objects such as light fixtures, plaster, bookcases, and falling cabinets. Immediately crawl under a desk or table located in a strong corner away from windows or move to a strong doorway. Do not attempt to rush outside; stairways may be unsafe, and exits may be jammed. When the shaking stops, evacuate immediately if you feel that the trailer/facility is unsafe.

(2) Outdoors. If outside, avoid walls, power poles, and other tall objects. Do not run through streets. If driving an automobile, stop in the safest place possible. Move to a safer and open area.

After the Quake

- Check for any personal injury and fires or fire hazards.
- Assist the injured to the best of your ability.
- Report for accountability to ensure that everyone is safe and accounted.
- Do not reenter the trailer/facility until a competent person examines it.

The Frontline Supervisor and IS/IH specialist have the following responsibilities.

- After the earthquake, evaluate damage reports to ensure building safety for occupancy (consider aftershocks).

- If the building/trailer is damaged but occupants can continue safely, direct nonessential personnel to exit the building, and report to local assembly point unless otherwise directed by the PSS.

- Check for personnel injury; look for fires or fire hazards; observe utility lines and equipment for damage. Follow applicable procedures for shutting down equipment.

- If damage is determined too extensive for continued occupancy, direct complete evacuation of the building/trailer.

- If building/trailer/area is evacuated, initiate personnel accountability at local point unless otherwise directed by the PSS.

7.21.6 Chemical/Hazardous Material Release

7.21.6.1 Definitions

Downwind of a Chemical Release. Persons in facilities downwind of chemical releases may be in danger. Immediate protective actions by persons downwind can significantly reduce the safety and health risks from an approaching chemical plume.

Shelter-in-Place. This term means to go indoors, close all windows and doors, and turn off all sources of outside ventilation.

7.21.6.2 Reporting an approaching chemical plume

Persons observing a chemical plume should warn other nearby persons verbally and, after taking protective action, report the emergency to the PSS by phoning Bell 333, 270-441-6333 by cell phone, or using radio Channel 16.

7.21.6.3 Receiving warning of an approaching chemical plume

Warning of an approaching chemical plume typically will come from the Paducah Site incident commander via the PA system accompanied by an order to either evacuate or to shelter-in-place. The first warning of an approaching chemical plume could be direct observation of the approaching plume by local personnel who verbally sound an alarm.

7.21.6.4 Protective actions for an approaching chemical plume

Evacuation. Upon receiving an order to evacuate, personnel should evacuate immediately per the directions given in the PA message or direct order. If no specific directions are given, personnel should evacuate at a 90 angle to the plume path and report to the appropriate off-site assembly point. Outside the plant security fence the assembly point is at the C-103 DOE office building.

Once at the off-site assembly area, personnel should report to their supervisor or other point of contact for accountability purposes and for other emergency information.

Shelter-in-Place. Upon receiving orders to shelter-in-place, persons should go inside, close all windows and doors, shut off all sources of outside ventilation, and remain there until the shelter-in-place order is lifted.

The following are the responsibilities of the Frontline Supervisor and IS/IH specialist.

- Assist the crew with evacuation.
- If building/trailer/area is evacuated, initiate personnel accountability at local assembly point unless otherwise directed by the PSS.
- Assist the crew with sheltering-in-place.
- Ensure windows, doors, and sources of outside ventilation are closed.
- Conduct a local accountability to ensure people who should be sheltered are sheltered.

7.21.7 Contingency Plan for Spills

7.21.7.1 Definitions

Spill. An unidentified or unanticipated release of a substance(s) to air, surface water, groundwater, soil, pavement, or other location where the substance presents a potential hazard or environmental impact.

7.21.7.2 Reporting a spill

When a spill is discovered, the Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist will contact the PSS immediately and convey as much information as possible (e.g., material involved, estimated quantity spilled/affected, location, affected personnel, other hazardous conditions).

7.21.7.3 Protective actions for spill

An effort will be made to stop the release and contain the spill using materials in the on-site spill response kit, only if it is safe to do so and if no unprotected exposures occur. The following PSS contact list should be used for non-emergency and emergency notifications.

- Plant telephone Bell System in an emergency—333
- Plant telephone Bell System in non-emergency—6211
- Plant radio channel 16—Alpha 1
- Cell phone in an emergency—270-441-6333
- Cell phone in a non-emergency—270-441-6211

In the event that personnel are exposed to hazardous chemicals or radioactive materials, appropriate emergency response action will be taken to remove the contaminated clothing. An emergency shower and eyewash station will be used to flush exposed skin and eyes, respectively. This emergency equipment will be maintained in a readily accessible location adjacent to the active work area.

If an acute exposure to airborne chemicals occurs or is suspected and the affected personnel are unable to escape the work zone, the Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist will contact PSS immediately for assistance. Rescue operations will not be performed unless the rescuers are dressed in the appropriate protective equipment.

The DOE prime contractor's project management will be responsible for ensuring all spills of hazardous materials are cleaned up and disposed of properly, including any material generated from the spill, unless otherwise directed.

The following are the responsibilities of the Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist.

- Ensure that spill containment is performed safely,
- Provide all known information to PSS to ensure proper response,
- Ensure that decontamination measures for exposed personnel are conducted safely and promptly, and
- Ensure that, if personnel are exposed to airborne chemicals and are unable to escape the work zone, rescue is not attempted unless rescue personnel are dressed in the appropriate protective equipment.

7.21.8 Bomb Threat or Device

WARNING: Do Not Use Radios or cell phones

Radio transmissions could cause a blasting cap (electronic initiator) to detonate prematurely. The use of radios or telephones near suspected devices or inside search areas could result in premature detonation of the explosive device.

7.21.8.1 Definitions

Bomb Threat. A communication by telephone, personnel contact, writing, or discovery through physical evidence that a hazard may exist involving an explosive device.

Explosive. A substance that, through chemical reactions, violently changes to a gaseous form and releases pressure and heat equally in all directions.

7.21.8.2 Bomb threat or device discovery response

Telephone Bomb Threat

Obtain as much and as accurate information as possible and have as many people as possible listen to the telephone call.

Immediately notify the PSS by phoning Bell 333, building operator, and your immediate supervisor.

Attempt to keep the caller talking. Try to determine the following:

- Location of the suspected item;
- Time of detonation;
- Size, type, and arming device;
- Who planted the device, why, and how;
- Where, when, and under what circumstances device was planted;
- Who gave this information to the caller; and
- Background noises, music, televisions, aircraft noise, etc.

Written Bomb Threat

Protect and preserve the written communication. Do not handle the communication excessively.

Immediately notify your immediate supervisor.

Personal Contact

Obtain as much and as accurate information as possible from the person to whom you are talking.

Immediately notify the PSS by phoning Bell 333, the building operator, and DOE prime contractor management.

Discovering an Explosive Device

Ensure that the object is not disturbed or moved.

Immediately notify the Paducah Site PSS by phoning Bell 333, the building operator, and the DOE prime contractor management.

Control access to the area.

7.21.8.3 Contractor accountability/assessment drills

The DOE prime contractor will participate in all Paducah Site accountability/assembly drills by sending all on-site project personnel to the appropriate assembly station for accountability if inside the plant. The Frontline Supervisor, Field Team Manager or designee, or IS/IH specialist will be responsible for accounting for all field personnel (including subtier subcontractor personnel) and reporting any unaccounted-for personnel to the emergency coordinator directing the drill.

7.22 CONFINED SPACE ENTRY

All confined space entries shall be in accordance with OSHA 29 *CFR* Part 1910.146; CP3-HS-2055, *Confined Space*; and the following requirements. Entry into a confined space is not expected to be needed during implementation of the SWMU 211-A EISB. The requirements provided below are not intended to be all-inclusive.

A confined space is considered to be any space that is large enough and so configured that it can be bodily entered to perform work, has limited or restricted means of entry or exit, and is not designed for continuous employee occupancy. Entry into a confined space will be considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Permit-required confined spaces are those spaces that have one or more of the following characteristics:

- Contain or have the potential to contain a hazardous atmosphere;
- Contain a material that has the potential for engulfing an entrant;
- Have internal configurations such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and
- Contain any other serious safety or health hazards.

7.23 SPILL CONTAINMENT

The intent of this section of the HASP is to meet the requirements of 29 *CFR* Part 1910.120 (b)(4)(ii)(j). The spill containment program shall address all hazardous substance spill scenarios that are likely to occur at the site. In addition, the spill containment program also shall provide procedures to contain and isolate the entire volume of any hazardous substance spilled in the course of a transfer, accident, or on-site release. Response to such an incident is specified in Section 7.21.7.

In order to implement successful spill containment during operations, an assessment shall be conducted of the site conditions, current operations, and planned activities. The assessment shall carefully examine all hazardous materials on-site to determine the following about the materials:

- Where and how materials are stored (e.g., location, type of container);
- How material are handled (e.g., processed, used, transferred); and
- How materials are transported (e.g., mode, routes).

As part of the assessment, each area or activity shall be analyzed for potential accidental releases or spills. The following are examples of situations that have potential for spill or release:

- Bulging or corroded containers;
- Transfer line connections (e.g., leaking seals, misaligned connections);
- Metal fatigue of storage tanks;
- Leaking or inoperable valves; and
- Poor housekeeping (e.g., drums improperly staged).

Many potential spills can be avoided through application of proper engineering controls to hazards identified in the assessment. In areas where storage, handling, and transportation activities occur, preplanning to contain the largest volume of material that could be released in the area will minimize worker exposure. The containment measure shall be appropriate to the hazardous material(s) identified and shall be installed in the area or located nearby. The following examples are measures that are most frequently used:

- Salvage containers (e.g., overpack drums);
- Bermed, lined pads;
- Concrete pad and dike;
- Inflatable containment (e.g., "kiddie" pools, bladders); and
- Associated equipment (e.g., pumps, hoses, shovels, hoists).

Spill containment equipment and fixtures shall be maintained and replaced properly, as necessary.

7.24 RECORDKEEPING

Proper safety recordkeeping is essential in the implementation of the HASP. The forms associated with the recordkeeping must be completed in an accurate, timely fashion. Completed forms will be kept and maintained by the project.

7.24.1 Records and Logs

The Frontline Supervisor and IS/IH specialist will maintain a record of each day's activities and work. Other relevant data and field information will be recorded on separate forms for air monitoring, sampling, equipment calibration, inspections, and incident reporting. An EZ entry log will be maintained that will provide a project record of the following information for each work shift's activities:

- Worker's name,
- Work area,
- Level of protection, and
- Time in/time out.

Personnel will be required to log in and out of the EZ and radiological controlled area.

7.24.2 Safety Inspections

Safety inspections are required by various tiers of the management structure. Each safety inspection is to be documented. Management and independent assessments shall be conducted in accordance with the DOE prime contractor's procedure CP3-QA-1003, *Management and Self Assessments*. These activities are conducted in accordance with CP3-OP-0050, *Performance Observations*. The primary responsibilities of the assessor include the following:

- Interviewing employees with regard to IS/IH specialist recommendations and how they might be integrated into the performance of work,
- Observing and correcting unsafe conditions and acts, and
- Verifying that corrective actions have been assigned to a responsible employee and implemented.

Positive safety observations and safety issues also should be documented. A list of corrective action items will be maintained showing the corrective action, responsible person, and the date action is to be completed. Completed reports are to be given to DOE prime contractor's management.

7.24.3 Accident/Incident Reporting and Investigation

Personnel should report all accidents and incidents, no matter how minor, to the Frontline Supervisor and/or IS/IH specialist as soon as possible. The Frontline Supervisor shall immediately notify PSS of any event or condition that adversely affects or may adversely affect DOE, the DOE prime contractor, the DOE prime contractor's subcontractors, the public, or government property. These events may include any accident/incident that results in employee injury/illness, accident precursor that could result in injury/illness or damage to government equipment and facilities, potential noncompliances, or any other unplanned event that may be a violation of a regulatory requirement or that may be viewed negatively by the public or DOE. In situations where an accident or incident has occurred, the scene may not be altered without PSS concurrence, unless alteration is necessary to protect human life, mitigate an immediate hazard, or stop a spill in progress.

PSS will investigate and report each accident or incident involving employee injury/illness, damage to government property (including vehicles), or any precursor incident that has the potential to result in these undesired outcomes. For personnel illness/injury or safety and health related issues, a Safety Notification Report shall be completed in a timely manner after the event as well as if environmental issues are involved and proper notifications will be made. If radiological/contamination control issues are involved, a Radiological Anomalous Condition Report shall be initiated. Such reports shall provide a description of the incident, direct and contributing causes, immediate corrective actions taken, and planned measures that will be taken to prevent recurrence of similar incidents. The DOE prime contractor's Occupational Medicine provider shall maintain an injury log listing occupational injuries/illness involving DOE prime contractor, DOE prime contractor subcontractor employees, or anyone else injured as a result of work performed under this contract. Investigation and reporting shall be conducted in accordance with the DOE prime contractor's procedure, CP3-OP-2024, *Initial Incident/Event Reporting.*

8. SAMPLING AND ANALYSIS

8.1 SAMPLING AND ANALYSIS

MW sampling will be conducted to assess the performance of the RA.

Post-implementation sampling and analysis is intended to achieve three main goals:

1. Assess the passive ongoing bioremediation in the subsurface,

2. Assess the ZVI for continued VOC reduction, and

3. Assess the continued reduction of TCE and degradation products in the RGA groundwater in support of attaining RAO 3.

The details for the performance of sampling and analysis efforts are included in Operations, Maintenance, and Environmental Monitoring Plan, Appendix A of the CFC RDR (DOE 2019a). Appendix A also includes information concerning the following:

- EISB maintenance
- Performance MW locations and construction details
- Long-term MW locations and construction details
- Baseline sampling
- EISB performance sampling frequency and analytical parameters
- Long-term monitoring sampling frequency and analytical parameters

Baseline, first-year performance, and long-term sampling will be performed by Environmental Monitoring sampling crews in support of the project. Beginning in the second year, sampling efforts and analytical requirements will be included in the PGDP Annual Environmental Monitoring Plan and scheduled with the other EMP sampling by the Environmental Monitoring sampling crews.

8.2 SAMPLING AND ANALYSIS REPORTING

Results from performance and long-term monitoring will be submitted to the FFA parties in Five-Year Reviews. Progress utilizing data from groundwater monitoring will be communicated or provided to the FFA parties, as necessary, between Five-Year Reviews:

- As interim updates, particularly during the initial five years of EISB implementation;

- Monitoring data associated with action will be available through the online program Portsmouth/Paducah Project Office (PPPO) Environmental Geographic Analytical Spatial Information System (PEGASIS) at the following hyperlink—https://pegasis.pad.pppo.gov/; and

- During groundwater project update calls as information is available.

As agreed to by the FFA managers, an Interim RACR for the SWMU 211-A EISB RA is scheduled for 2023. The Interim RACR will include Postconstruction Report elements and will be submitted in the near-term. This document also will provide the FFA parties, as well as stakeholders, the results of the EISB action available at the time of report preparation. Implementation of the SWMU 211-A EISB RA will be

included in the Southwest Plume Sources section of the FFA Semiannual Progress Reports, consistent with FFA Appendix D, Document Outlines. A final RACR will be submitted in the future upon achievement of the long-term RAOs and remedial goals identified in the ROD for this SWMU.

8.3 SOURCE WATER SAMPLING

The source of water for use in performing the EISB RA is expected to be obtained from the PGDP water system via a nearby fire hydrant or spigot. A pre-use sample will be obtained to confirm the quality of the water from the system. The water sample collected will be analyzed for VOCs (8260C) and Resource Conservation and Recovery Act (RCRA) 8 metals (6010, 6020, and 7470). At the start of the RA, if the VOCs and RCRA 8 metals information is available for the PGDP water system from earlier samples, that information may be used in lieu of additional analyses.

9. QUALITY ASSURANCE PLAN

A QAPP ensuring implementation of EISB for SWMU 211-A for VOC sources to the Southwest Plume and post-implementation sampling is based on guidelines in *Uniform Federal Policy for Quality Assurance Project Plans*, and is presented in the Appendix of this RAWP.

The governing QA documents for this RA include, but are not limited to, the QAPP and the *Quality Assurance Program Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-QA-1000, and the *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan*, DOE/LX/07-2459&D1 (DOE 2021).

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10. DATA MANAGEMENT AND IMPLEMENTATION PLAN

10.1 INTRODUCTION

The purpose of this Data Management Implementation Plan (DMIP) is to identify and document data management requirements and applicable procedures, expected data types and information flow, and roles and responsibilities for all data management activities associated with the SWMU 211-A EISB RA project. Data management provides a system for efficiently generating and maintaining technically and legally defensible data that provide the basis for making sound decisions regarding ER and waste characterization at the Paducah Site.

Data management for this project is implemented throughout the life cycle for the environmental measurements data. This life cycle occurs from the planning of data for environmental and waste characterization, through the collection, review, and actual use of the data for decision-making purposes, to the long-term storage of data.

Data types to be managed for the project include field data and analytical data. Historical data are downloaded from Paducah OREIS, as available. Field data will be collected in field logbooks or field data forms, and the data will be entered into Paducah Environmental Measurements System (PEMS), as appropriate, for storage. Analytical data are planned and managed through PEMS and transferred to Paducah OREIS for long-term storage and reporting. Environmental data are transferred from Paducah OREIS to PEGASIS. RAD survey results are stored and reported separately from PEMS and Paducah OREIS. In addition to the above, during the EISB process, real-time operational/injection process data will be collected. These data provide a means for determining the quantity of biological amendments and other materials.

To meet current regulatory requirements for DOE environmental management projects, complete documentation of the information flow is established. Each phase of the environmental data management process (planning, collecting, analyzing, managing, verifying/validating, assessing, reporting, consolidating, and archiving) must be planned and documented appropriately. The SWMU 211-A EISB RA project team is responsible for data collection and data management for this project.

The scope of the DMIP is limited to environmental information generated under the SWMU 211-A EISB RA project. This information includes electronic and/or hard copy records obtained by the project that describe environmental processes or conditions. Both information generated by the project (e.g., laboratory analytical results from samples collected) and information obtained from sources outside the project (e.g., historical data) fall within the scope of this DMIP. Certain types of information, such as personnel or financial records, are outside the scope of this DMIP.

10.1.1 Project Mission

The mission of the SWMU 211-A EISB RA project is reduction of the VOC source (TCE and breakdown products) in the UCRS subsurface soils at the SWMU 211-A source area to attain the RAOs. As part of the SWMU 211-A RA, two distinct phases of sampling and analysis will occur: performance sampling and long-term groundwater monitoring. Both of these sampling components occur after injection of the biological amendments into SWMU 211-A. Baseline sampling also will occur prior to the injection of the biological amendments. Performance sampling and analysis will be used to measure biological progress and to determine what effects the RA has on the subsurface contaminants. Results from each round of performance sampling and analysis will be compared to baseline results and previous sampling rounds to determine the degree of bioremedial activity occurring in the UCRS. Long-term sampling will be performed

to determine VOC levels entering the RGA below the treatment area, determine the reduction in VOC levels in the RGA as it migrates away from the treatment area, and determine the degree to which RA goals are being achieved.

10.2 DATA MANAGEMENT ACTIVITIES

- Acquire existing data;
- Plan data collection;
- Prepare for sampling activities;
- Collect field data;
- Process field data;
- Collect field samples;
- Submit samples for analysis;
- Process laboratory analytical data;
- Laboratory Contractual Screening;
- Data verification;
- Data validation;
- Data assessment;
- Consolidate, analyze, and use data and records; and
- Submit data to Paducah OREIS.

10.2.1 Acquire Existing Data

The primary background data to be used for this project consist primarily of analytical data. All available historical data pertaining to the area included in the SWMU 211-A EISB will be downloaded from Paducah OREIS and utilized as necessary in implementing and monitoring the effects of the RA. This data has been used in the development of the decision documents used to select the RA. It has been utilized further in development of the remedial design of the RA.

10.2.2 Plan Data Collection

Other sections and subsections in this RAWP provide additional information for the tasks of project environmental data collection, including the performance and long-term sampling activities, HASP, the QAPP, and the WMP. In addition, a laboratory SOW will be developed in accordance with CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*, following approval of this work plan.

10.2.3 Prepare for Sampling Activities

The data management tasks involved in sample preparation activities, as specified in CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*, include identifying all sampling locations and preparing descriptions of these locations, developing summaries of all the samples and analyses to be conducted at each sampling location consistent with planning documents and work plans, identifying sample containers and preservation, developing sample data forms for capturing field data, preparing sample kits and chain-of-custody forms, and coordinating sample delivery to the laboratories. The SMO conducts activities associated with analytical laboratories. Coordinates for sample locations will be obtained using a Global Positioning System (GPS) and/or civil survey. The SWMU 211-A EISB RA project manager or the field team manager and the SMO will coordinate data management activities with field sampling activities.

Before the start of field sampling, the SMO will specify and provide the contents of sample kits, which will include sample containers, labels, preservatives, chain-of-custody forms, and any necessary sampling data forms. Samples will be collected according to contractor-approved procedures. Logbooks, sample labels, and chain-of-custody forms will be completed according to CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*, and CP4-ES-2700, *Logbooks and Data Forms*. Sampling information contained in Sections 8, 9, and Appendix A of this RAWP, and Appendix A of the CFC RDR will be used as the basis for determining the following:

- Sample collection;
- Ordering sufficient amount of containers and other supplies; and
- Verifying the numbers of samples presented in the laboratory scope of work.

As a result of the type of remediation, real-time process field data collection will occur during operations. The measurement of these data points and readings will be performed by field instruments that require periodic calibration consistent with the manufacturer's direction.

10.2.4 Collect Field Data

Field data will be collected, documented, and maintained according to the requirements contained in this document and in the approved CFC RDR and contractor-approved procedures.

10.2.5 Process Field Data

Field measurements such as pressures, volumes, times, etc., will be recorded on sample data forms, field project forms, or in data collection equipment. The sample data forms will be used for entering data manually into Paducah PEMS.

PEMS is used to identify, track, and monitor each sample and associated data from the point of collection through final data reporting. Project documentation includes sample data forms, chain-of-custody forms, and analytical results.

Data management requirements for sample data forms and field forms specify that (1) sampling documentation must be controlled from initial preparation to completion, (2) sampling documentation must be maintained in a project file, and (3) modifying planned activities and deviating from procedures will be recorded.

Before the start of sampling, the SMO specifies the contents of sample kits, which include sample containers provided by the laboratories, preservatives, and chain-of-custody forms. Sample labels and chain-of-custody forms are completed according to CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*.

10.2.6 Collect Field Samples

Personnel collecting samples for the project will record pertinent sampling information on the chain-of-custody forms and sample data forms. The SMO will enter the information from the chain-of-custody forms and sample data forms manually into PEMS. Sampling locations will be surveyed using a GPS and/or civil survey, which will have at least sub-meter accuracy. Sample coordinates will be transferred to the plant coordinate system.

10.2.7 Real-Time Process Sampling and Analysis

Process monitoring data such as injection pressures, volumes, times, etc., will be collected during injection operations. This process monitoring data will be recorded on field project forms or on electronic data forms if available. Process samples or real-time samples are samples that are collected to show removal or destruction of a COC as a result of the process. EISB occurs in the subsurface after completion of amendment injections and the required subsurface chemistry has been generated over an extended period of time. Because of the delay in the treatment process, samples are not collected during injection operations. After injection is completed, performance and long-term monitoring begins and will be performed consistent with this RAWP and the CFC RDR.

10.2.8 Submit Samples for Analysis

The sampling team coordinates the delivery of samples with the SMO who, in turn, coordinates with the analytical laboratories, according to CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*. The SMO presents a general sampling schedule to the analytical laboratories. The SMO also coordinates the receipt of samples and containers with the laboratories. The SMO ensures that laboratory data packages and electronic data deliverables (EDDs) from the laboratories contain the appropriate information and are in the correct format.

10.2.9 Process Laboratory Analytical Data

Data packages and EDDs received from the laboratory are tracked, reviewed, and maintained in a secure environment. PEMS is used for tracking project-generated data. The following information is tracked, as applicable: sample delivery group number, date received, number of samples, sample analyses, receipt of EDD, and comments. The laboratory EDDs are checked as specified in CP4-ES-5007, *Data Management Coordination*.

10.2.10 Laboratory Contractual Screening

Laboratory contractual screening is the process for evaluating a set of data against the requirements specified in the analytical SOW to ensure that all requested information is received. The contractual screening includes, but is not limited to, the analytes requested, total number of analyses, method used, EDDs, units, holding times, and reporting limits achieved. Contractual screening is performed for 100% of the data. The SMO is responsible for the contractual screening upon receipt of data from the analytical laboratory according to CP3-ES-5003, *Quality Assured Data*.

Real-time process data is reviewed by the system operator through the data acquisition system or on project data forms. This data includes pressures, volumes, times, etc. The real-time data collected will be available for use by the project team and utilized in developing project reports.

10.2.11 Data Verification

Data verification is the process for comparing a data set against a set standard or contractual requirement. Verification is performed by the SMO electronically, manually, or by a combination of both according to CP3-ES-5003, *Quality Assured Data.* Verification is performed for 100% of the data. Data verification includes contractual screening and criteria specific to the SWMU 211-A EISB RA project. Verification qualifiers may be applied to the data based on holding time exceedance, criteria exceedance, historical exceedance, or background exceedance, if applicable. Verification qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Additional information relating to data verification is included in the QAPP in the appendix to this document.

10.2.12 Data Validation

To ensure the quality of the analytical data, all laboratory data packages will be produced by the laboratory performing the analysis as Level IV laboratory data deliverables, to the extent possible. Level IV data deliverables contain all raw data and QC such that data verification and data validation of all sample collection, sample handling, sample preparation, analytical performance, data reduction, and data manipulation (i.e., calculations and weights) can be performed.

Data validation is the process performed by a qualified third-party individual. Third-party validation is defined as validation performed by persons independent of sampling, laboratory, and decision making for the program/project (i.e., not the program/project manager). Data validation evaluates the laboratory adherence to analytical-method requirements. Data validation is managed and coordinated with the SMO. The data validator performs data validation according to DOE prime contractor data validation plans. Data validation is documented in a formal deliverable from the data validator. Validation qualifiers are input and stored in PEMS and transferred to Paducah OREIS.

A minimum of 10% of the total number of SWMU 211-A EISB RA project samples will be validated for this project. Data validation will apply only to the definitive data.

10.2.13 Data Assessment

Data assessment is the process for assuring that the type, quality, and quantity of data are appropriate for their intended use. It allows for the determination that a decision can be made with the desired level of confidence, given the quality of the data set. Data assessment follows data verification and data validation (if applicable) and must be performed at a rate of 100% to ensure data is usable.

The data assessment is conducted by the SWMU 211-A EISB RA project according to CP3-ES-5003, *Quality Assured Data.* Assessment qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Any problems found during the review process are resolved and documented in the data assessment package.

10.2.14 Data Consolidation and Usage

The data consolidation process consists of the activities necessary to prepare the evaluated data for the users. The SMO prepares files of the assessed data from PEMS and transmits them to Paducah OREIS for future use in accordance with CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System.* The SMO is responsible for transferring the data to Paducah OREIS. Data used in reports distributed to external agencies are obtained from data in Paducah OREIS and have been through the data review process. All data reported have the approval of the SMO.

10.3 DATA MANAGEMENT INTERACTIONS

The SMO oversees the use of PEMS and ensures that data deliverables meet DOE's standards. The SMO enters information into PEMS related to the fixed-base laboratory data once the samples have been delivered, and the results of analyses have been received. The fixed-base laboratory EDDs are loaded into PEMS by the SMO. The SMO performs electronic data verification and coordinates data validation. The SWMU 211-A EISB RA project is responsible for data assessment. The SMO is responsible for preparing the data for transfer from PEMS to Paducah OREIS.

SMO develops the SOW to be performed by an analytical laboratory in the form of a project-specific laboratory SOW. Analytical methods, reporting limits, and deliverable requirements are specified in this SOW.

The SMO receives EDDs, performs contractual screenings, distributes data packages and ensures that electronic deliverable formats are specified properly, and interfaces with the laboratory to ensure the requirements are understood and met.

10.4 DATA NEEDS AND SOURCES

10.4.1 Data Types

Multiple data types will be generated and/or assessed during this project. These data types include field measurements, inspection checklists, historical data, analytical data (including environmental data and waste data), and geographic information system (GIS) data.

10.4.2 Field Measurements

Field measurements that may be collected include field measurements of environmental and waste samples and GPS readings for each sample location. Field measurements may be recorded on appropriate logbooks or sample data forms. The SMO will enter the data from these forms, manually or from the electronic recorder devices, into Paducah PEMS. A QC check of this data entry will be conducted.

10.4.3 Analytical Data

Analytical data for the project consist of volatile analyses, bacterial analyses, hydrocarbon gases, and organic carbon concentrations from groundwater samples.

10.5 GEOGRAPHIC INFORMATION SYSTEM DATA

The Paducah GIS network is used to prepare maps used in data analysis and reporting of both historical and newly generated data. Coordinates will be recorded as state plane coordinates along with plant coordinates. The following details the coverage anticipated for use during the project.

- Stations (station coordinates will be downloaded from Paducah OREIS)
- Facilities
- Plant roads
- Plant fences
- Topographic contours (as available from the 1990 and most recent flyover)
- Utilities
- Creeks/Streams
- Monitoring and injection wells
- Plumes

10.6 DATA FORMS/LOGBOOKS

Field logbooks, chain-of-custody forms, data packages with associated QA/QC information, and sample data forms are maintained properly according to CP3-RD-0010, *Records Management Process*.

Duplicates of field records are maintained until the completion of the project. Logbooks and field documentation are copied periodically. The originals are forwarded to Records Management, and copies are maintained in the field office.

10.6.1 Field Forms

On sample data forms, chain-of-custody forms, or sample labels, this information is entered directly into PEMS by the SMO.

Chain-of-custody forms contain sample-specific information recorded during collection of the sample. Any deviations from the sampling plan are noted on the chain-of-custody form or sample data form. The Sampling Team reviews each chain-of-custody form for accuracy and completeness, as soon as practical, following sample collection.

Chain-of-custody forms are generated from PEMS with the following information:

- Information that is preprinted
  - Chain-of-custody number
  - Project name or number
  - Sample ID number
  - Sampling location (e.g., MW203, PW001)
  - Sample type (e.g., REG = regular sample)
  - Sample matrix (e.g., WG = Groundwater)
  - Analysis (e.g., TCE)
  - Sample container (volume, type, preservation)

- Information that is entered manually
  - Sample date and time
  - Top and bottom depths and units (if applicable)
  - Sample comments (optional)
  - Preservation method

The performance monitoring and long-term monitoring that will be performed as part of this RA involve collecting only groundwater samples. A listing of the groundwater samples to be collected is contained in Table 2 and Table 3, Appendix A, *Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2019a). The following is an example of the sample identification naming convention.

211AMW203XXYY

where:

211A	Designates the SWMU 211-A EISB RA project
MW203	Identifies the monitoring well location (PW001–indicates performance well location)
XXYY	Quarter and Year of Sample

Well Construction Details Forms

Well construction details forms will be used as necessary for this project. Well construction and installation are entered into the field logbook and later added to a well construction detail form. Copies of the well

construction details forms will be provided to the SMO and GIS organizations in order for the information to be added to Paducah OREIS and PEGASIS. An example of a completed well construction detail form can be found in CP4-ES-0069, *Monitoring Well and Associated Infrastructure Installation*.

10.7 DATA AND DATA RECORDS TRANSMITTALS

Official data reporting will be generated from data stored in Paducah OREIS.

10.8 DATA MANAGEMENT SYSTEMS

10.8.1 PEMS

PEMS is the data management system that supports the project's sample and measurement collection activities and generates Paducah OREIS ready to load (RTL) files. The SMO accesses PEMS throughout the life cycle of the project. The SMO uses PEMS to support the following functions.

- Initiate the project properly
- Plan for sampling
- Record sample collection and field measurements
- Record sample shipment information
- Receive and process analytical results
- Evaluate and verify data
- Access and analyze data
- Assess data and enter data validation qualifiers
- Transfer project data (in RTL format) to Paducah OREIS
- Store non-Paducah OREIS

PEMS is used to generate chain-of-custody forms and sample data forms, import laboratory-generated data, update field and laboratory data based on data verification, data validation if applicable, data assessment, and transfer data to Paducah OREIS. Requirements for addressing the day-to-day operations of PEMS include backups and security.

The Information Technology group performs system backups daily. The security precautions and procedures implemented by the SMO are designed to minimize the vulnerability of the data to unauthorized access or corruption. Only members of the SMO have access to the project's PEMS and the data files.

10.8.2 Paducah OREIS

Paducah OREIS is the centralized, standardized, quality assured, and configuration-controlled data management system that is the long-term repository for environmental data (measurements and geographic) for Paducah environmental projects. Paducah OREIS is comprised of hardware, commercial software, customized integration software, an environmental measurements database, a geographic database, and associated documentation. The SWMU 211-A EISB RA project will use Paducah OREIS for the following functions.

- Access to existing data
- Access to project data
- Report generation
- Long-term storage of project data (as applicable)

10.8.3 Paducah Analytical Project Tracking System

The Paducah Analytical Project Tracking System is the business management information system that manages analytical sample analyses for Paducah environmental projects. The Paducah Analytical Project Tracking System generates the SOW, tracks collection and receipt of samples by the laboratory, flags availability of the analytical results, and allows invoice reconciliation. The Paducah Analytical Project Tracking System interfaces with PEMS (output from the Paducah Analytical Project Tracking System is transferred automatically to PEMS).

10.8.4 PEGASIS

The PEGASIS application provides a systematic approach to retrieve, display, and download analytical, geotechnical, and hydrological data, maps, and geophysical information for PPPO sites, regulators, and the public using a web browser. The information includes analytical sample results from various environmental studies, restoration reports and supporting documents, maps, facility drawings, and photography.

PEGASIS is a website that allows data users to access sampling data for hundreds of investigative wells and sampling events, SWMUs, and site-specific GIS features from all of the environmental studies at the site. Analytical data available on PEGASIS are copied from Paducah OREIS periodically.

10.9 DATA MANAGEMENT ROLES AND RESPONSIBILITIES

The data management activities are described in Section 10.2. Contractor-approved procedures will be used to complete all of the necessary data management tasks. The following project roles are defined, and the responsibilities are summarized.

10.9.1 DOE Prime Contractor SWMU 211-A Project Manager

The SWMU 211-A project manager is responsible for the day-to-day technical operation of the RA project. The project manager ensures the requirements of policies and procedures are met. The project manager or designee assesses data in accordance with CP3-ES-5003, *Quality Assured Data*. The project manager is responsible to flow down data management requirements to subcontractors, as required.

10.9.2 DOE Prime Contractor Project Team

This team consists of the technical staff and support staff (including the SMO) that conduct the various tasks required to complete the project successfully.

10.9.3 Data User

Data users are members of the project team who require access to project information to perform reviews, analyses, or ad hoc queries of the data. The data user determines project data usability by comparing the data against predefined acceptance criteria and assessing that the data are sufficient for the intended use.

10.9.4 DOE Prime Contractor SMO

The SMO enters the data into Paducah PEMS, including chain-of-custody information, field data, data assessment and data validation qualifiers, and any pertinent sampling information. After receiving a notification that a fixed-base laboratory EDD is available to download, the SMO loads the EDD to Paducah

PEMS, performs electronic verification of the data, and then compiles the data assessment package. The SMO also prepares data for transfer from PEMS to Paducah OREIS.

The SMO is responsible for contracting any fixed-base laboratory utilized during the sampling activities. The SMO also coordinates sample shipment to the laboratory, ensures contractual screening of data packages, coordinates data validation support, and ensures transmittal of data packages to Records Management.

10.9.5 DOE Prime Contractor Project Records Custodian

The Project Records Custodian is responsible for the long-term storage of project records. The SWMU 211-A project team will interface with the Project Records Custodian and will transfer documents and records in accordance with DOE requirements.

10.9.6 DOE Prime Contractor QA Specialist

The QA Specialist is part of the project team and is responsible for reviewing project documentation to determine if the project team followed applicable procedures.

10.9.7 DOE Prime Contractor Environmental Monitoring and SMO Manager

The Environmental Monitoring and SMO Manager is responsible for long-term storage of project data and for transmitting data to external agencies according to the *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities,* DOE/OR/07-1595&D2, and the Paducah Data Management Policy. The Environmental Monitoring and SMO Manager ensures compliance with procedures relating to data management with respect to the project and that the requirements of CP3-ES-5003, *Quality Assured Data,* are followed.

11. ENVIRONMENTAL COMPLIANCE

11.1 INTRODUCTION

Environmental regulatory compliance will be facilitated during the implementation of the SWMU 211-A RA by complying with ARARs that have been identified throughout the project planning, scoping and decision making process, and documented in the signed ROD. CERCLA, as amended, requires, in part, that RAs for cleanup of hazardous substances comply with ARARs. Because this EISB RA project will be conducted entirely on-site in accordance with Section XXI of the FFA for PGDP and Section 121(e)(1) of CERCLA, no federal, state, or local permits are required for any portion of the EISB RA project.

The EISB RA project with Interim LUCs will reduce the source of TCE and other VOC contaminants that result in groundwater contamination in the SWMU 211-A area. Upon initiation of the RA, a continued decrease is expected in concentrations of TCE and other VOCs in the UCRS soils and groundwater.

The ARARs/to be considered (TBC) listing associated with the SWMU 211-A RA are contained in Appendix A of the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0365&D2 (DOE 2012). A summary of the ARARs/TBCs associated with this RA follows.

11.2 CHEMICAL-SPECIFIC ARARS/TBCS

These requirements provide health or risk-based concentration limits or values in environmental media for hazardous substances, pollutants, or contaminants. Consistent with the ROD, there were no chemical-specific ARARs/TBCs identified for this SWMU 211-A RA.

11.3 LOCATION-SPECIFIC ARARS/TBCS

Location-specific requirements establish restrictions on activities conducted within protected or environmentally sensitive areas. In addition, these requirements establish restrictions on permissible concentrations of hazardous substances within these areas. Section 11.5 provides additional information concerning the ARARs for this RA; the ARARs are located in the ROD (DOE 2012).

11.3.1 Protection of Wetlands

No wetlands have been mapped in the area near SWMU 211-A; therefore, performance of the remedial activities and installation of mixing and injection systems are not expected to impact delineated or nondelineated wetlands during the remedy implementation. The area of implementation is covered with pavement, gravel, or grass-covered soil and is bisected by a small storm-drainage ditch. There are, however, storm drains in the treatment area. In order to protect wetlands that are located away from the treatment area, all activities have been designed to avoid or minimize impacts to wetlands. The use of best management practices (BMPs) and proper siting of equipment and construction areas also will be considered and conducted, as necessary, to prevent impacts to wetlands in other areas of PGDP.

11.3.2 Protection of Aquatic Ecosystems

There are no aquatic systems in or nearby the EISB treatment area. Performance of the RA may include placement of a limited amount of backfilled material around the injection wells and MWs to create a level working surface. There are storm drains and a drainage ditch that could lead to an aquatic system located elsewhere in or outside of PGDP. All activities have been designed to avoid or minimize impacts to waters of the United States within the area of deployment of the RA. The use of BMPs and proper siting of equipment, construction areas, and placement of sediment migration control material will be determined and performed, as necessary, to comply with these substantive requirements to protect aquatic systems.

11.4 ACTION-SPECIFIC ARARS/TBCS

Action-specific ARARs include requirements that pertain to the operation, performance, and design of a remedial response and are based on waste types, media being treated, and treatment technology being implemented. Activities for this RA include drilling, placement of biological amendments in the subsurface, use of temporary mixing equipment, MW surface completions, and groundwater sampling. The actual treatment of the VOC contaminants occurs *in situ* within UCRS soils. The approach for meeting the requirements of the ARARs during the RA implementation is described below.

11.4.1 Fugitive Dust Emissions

Substantive requirements for the control of fugitive dust provide ARARs for all construction and site preparation activities for this project. Reasonable precautions must be taken, including the application of water on exposed soil/debris surfaces to prevent particulate matter from becoming airborne. The substantive requirements are contained in 401 *KAR* 63.010. In addition, diffuse or fugitive emissions of radionuclides to the ambient air from remediation activities, which are only one of potentially many sources of radionuclide emissions at a DOE facility, must comply with the Clean Air Act of 1970, as amended, requirements in 40 *CFR* § 61.92 (substantive requirements).

General surface activities have the potential to create dust. The treatment area is covered by pavement, gravel and grass covered soil. Soils generated during drilling activities will be moist and are not expected to result in the generation of dust. The limited backfilling operations around MWs may generate limited dust. Water sprays and ground covers will be used as needed to prevent generation of dust, including any coring of pavement surfaces. The preparation of ZVI and sand mixtures for the purpose of fracturing will involve mixing of the materials which could generate a limited amount of dust. As with ground generated dust, water sprays will be utilized as needed to prevent the generation of iron or sand dust.

11.4.2 Toxic Emissions and Operation Emissions

SWMU 211-A potential hazardous air pollutants (HAPs) have been identified based on characterization of the soils and development of decision documents. The potential HAPs identified are TCE, vinyl chloride, *trans*-1,2-DCE, *cis*-1,2-DCE, and 1,1-DCE. The RA chosen for this SWMU is EISB and interim LUCs, which will not extract these contaminants from the subsurface. The contaminants will be treated *in situ*. The RA will not generate toxic emissions and will not require the treatment of vapor/gases to comply with the contaminant concentration requirements of 401 *KAR* 63:020.

11.4.3 Monitoring Well Installation

This RA will use injection wells to treat subsurface contaminants *in situ.* Performance wells and long-term MWs will be used to ascertain the efficacy of the biological reactions and to determine the degree to which

the action will result in attaining RAOs. The injection wells will be used to place sand, ZVI, vegetable oil emulsion, and bacteria cultures into the subsurface. The combination of these materials in the subsurface will generate biological reactions to destroy the VOC contaminants. Performance wells will be installed to obtain samples of the water inside the treatment area to determine the operational efficiency. Long-term MWs will be installed around the treatment area to assist in assessing the degree to which the RAOs are being attained. Consistent with 401 *KAR* 6:350, these well components will be installed to minimize the potential for the introduction of pollutants into the subsurface. A Commonwealth of Kentucky licensed well driller will be utilized for MW installation and abandonment. Plugging and abandoning of the wells is not planned because the wells will remain in place for a number of years to support ongoing EISB. If needed, they could be used to add additional biological amendments to promote continued biological remediation.

11.4.4 Discharge of Collected Storm Water and Treated Groundwater

Management of aqueous wastes will include procedures to minimize the possibility of spills and releases to the environment. As a BMP, temporary berms will be constructed, as needed, around drilling rigs and other equipment to minimize contact of chemicals or waste with surface water run-on and runoff. If precipitation accumulates in the bermed areas that hold contaminated wastes, it will be managed as contaminated water until analyses show otherwise. It will be treated, as needed, at facilities such as C-612 Treatment Facility to meet ARARs (surface water discharge limits) prior to discharge, if necessary.

Contaminated water, including decontamination water, and development groundwater will be treated on-site as necessary (C-752-C and C-612 Treatment Facility) to meet discharge requirements as contained in the ARARs located in the ROD and subsequently discharged through a Kentucky Pollutant Discharge Elimination System (KPDES) or CERCLA outfall (DOE 2012). Where these waters cannot be treated on-site, they will be shipped to an appropriate off-site wastewater treatment facility for treatment and subsequent disposition in accordance with applicable requirements. Off-site shipment to any facility shall be conducted in accordance with the applicable requirements of 40 *CFR* § 300.440 (CERCLA Off-site Rule).

The use of the tanks for containerizing the generated water will allow for batch sampling. The *MEMORANDUM OF AGREEMENT FOR RESOLUTION of Informal Dispute for the Focused Feasibility Study for the Southwest Plume Volatile Organic Compound Sources Oil Landfarm and C-720 Northeast and Southeast sites) at the Paducah Gaseous Diffusion Plant, Paducah, KY* (DOE/LX/07-0186&D2), paragraph 2, requires that the method for calculating the annual average discharge (AAD) of Tc-99 shall be detailed (DOE 2010b). Because effluent water will be containerized and sampled prior to discharge, this same process will be used to determine AAD of Tc-99. After each tank has been filled to the appropriate level, each tank will be sampled and analyzed for the Tc-99 activity present in the water contained in the tank. The volume of the filled tank will be noted upon sampling. These two data points (water volume and Tc-99 activity) will be collected for each filled tank throughout the project. The laboratory results for the Tc-99 and volumes of the tanks then will be used to calculate a volume weighted average discharge for the project to help determine the AAD at the outfall(s) in conjunction with contributions from any other CERCLA discharges subject to this ARAR.

If the project operation does overlap fiscal/calendar years, the average annual discharge for Tc-99 will be calculated for the operational discharges that occurred during each fiscal/calendar year.

The following equation provides the detail for the AAD calculation.

Where:

AAD = Annual Average Discharge, pCi/L
N = Total Number of Wastewater Tanks, #
X_N = Tc-99 activity in each tank, pCi/L
V_N = Volume of water in tank N, gal

$$AAD = [(X_1V_1 + X_2V_2 + X_3V_3 + \ldots X_NV_N)/(V_1 + V_2 + V_3 + \ldots V_N)]$$

Note: Field implementation of the bioremedial activity is expected to be less than one year; therefore, the AAD is not expected to require normalization for multiple years.

11.4.5 Hazardous Waste Management

All primary wastes (i.e., groundwater and contaminated soils) and secondary wastes (i.e., treatment residuals and decontamination wastewaters) generated during remedial activities will be characterized as RCRA wastes (solid or hazardous); PCB waste; radioactive waste(s); and/or mixed waste(s), as appropriate, and will be managed in accordance with appropriate RCRA, Toxic Substance Control Act (TSCA), or DOE Order/Manual requirements. Wastes managed on-site must comply with the requirements of the ARARs contained in the signed ROD (DOE 2012). When wastes are transferred off-site, waste management must be conducted in compliance with all applicable laws and regulations. Shipment of CERCLA wastes to any off-site facility shall be conducted in accordance with the approval requirements of 40 *CFR* § 300.440 *et seq.* (CERCLA Off-site Rule).

For contained-in/no-longer-contaminated-with determinations for environmental media and debris, DOE will apply the contained-in/no-longer-contaminated levels of 39.2 ppm TCE in solids and 0.081 ppm TCE in aqueous wastes generated by this RA. The analytical results will be compared against the contained-in, health-based levels listed above, and a determination made. Land disposal restrictions (LDRs) continue to apply to media and debris for which a contained-in/no-longer-contained-in or a no-longer-contaminated-with determination has been made.

11.4.6 National Emission Standards for Hazardous Air Pollutants

EPA regulations also include limitations on the RAD dose allowed to members of the public in the National Emission Standards for Hazardous Air Pollutants regulations in 40 *CFR* Part 61 (and 401 *KAR* 57:002, which incorporates the federal regulations by reference). Codified at 40 *CFR* § 61.92, there is a limit of 10 millirem (mrem)/year from all radioactive air emissions at a DOE facility to the most exposed member of the public from radionuclide emissions to the atmosphere.

Tc-99 is the radionuclide that is expected to be present in the groundwater at SWMU 211-A. Because this RA will occur at natural temperature conditions and the materials will not be heated, Tc-99 will not vaporize. Moreover, because treatment will occur in the subsurface, radioactive emissions of Tc-99 are not expected to occur. Because the Tc-99 will remain in the liquid phase, there will be no release of vapor phase Tc-99 that will exceed the 10 mrem/year limit.

11.4.7 Transportation

Any remediation wastes transferred or transported in commerce along public rights-of-way must meet all applicable requirements found in the federal and Commonwealth of Kentucky transportation laws and

regulations. These transportation requirements include provisions for proper packaging, labeling, marking, manifesting, recordkeeping, licensing, and placarding that must be complied with fully for shipment. Before shipment of CERCLA wastes to any off-site facility, DOE must ensure the acceptance of the receiving site under the CERCLA Off-site Rule (40 *CFR* § 300.440).

11.4.8 Underground Injection Control

The project design for this RA requires implementation of EISB. This action will include the use of jet injection to create fractures in the UCRS formation. Those fractures will be filled with proppant which will allow the UCRS formation to more readily receive injected materials. The proppant will contain a mixture of water, guar gum, sand, and ZVI particles. Following the jet injection fracturing activity, injection of emulsified vegetable oil and water and *Dehalococcoides* bacteria will be performed to initiate the biological reduction of VOC contaminants in the UCRS treatment area.

Injection of vegetable oil emulsion, ZVI, *Dehalococcoides* bacteria, sand, guar gum, and water, which are not hazardous wastes, into the UCRS triggers certain ARARs under the Underground Injection Control (UIC) program of the Safe Drinking Water Act. Accordingly, the following substantive requirements of the UIC regulations are considered relevant and appropriate: (1) 40 *CFR* § 144.12(a), and 144.82(a). These regulations, in general, prohibit any injection activity that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation or standard or may otherwise adversely affect the health of persons. The utilization of injection wells to place the bioamendments and to effect the jet fractures qualifies the injection wells as aquifer remediation wells. Although aquifer remediation wells may be used for several purposes, for SWMU 211-A, they are for placement of remediation agents and microorganisms (EPA 1999). The implementation of the RA is being performed under CERCLA; as such, approval of the remedial design and RA work plan by the FFA parties provides the needed approval that allows the use of aquifer remediation wells.

The injection of the components described in the previous paragraphs will contribute to the efficiency of the *in situ* bioremediation operation and result in an overall reduction in VOC concentrations in the UCRS. The area affected by the injection of biological amendments is expected to be limited to the immediate area within the treatment zone as a result of hydraulic control measures that will be taken during injection operations. Hydraulic controls include the use of controlled injection volumes to reduce subsurface pressures. Controlling the injection volumes at various depths and targeted screens reduces the ability for contamination to migrate outside the treatment area by keeping subsurface pressures low. The design of this remedy is intended to meet the substantive requirements of 40 *CFR* § 144.12(a) and 144.82(a). The injections are designed to maintain control of injected material to prevent movement of fluid containing any contaminant into underground sources of drinking water. The RAWP will be approved by the EPA and Commonwealth of Kentucky.

11.5 SUMMARY OF ARARS

The RA will be performed using the location-specific and action-specific ARARs/TBCs for the selected remedy as documented in the ROD (2012a). No chemical-specific ARARs/TBCs were identified for this RA.

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12. WASTE MANAGEMENT PLAN

12.1 OVERVIEW

This WMP documents management and disposition of remediation waste, decontamination water, and wastewater that will be generated during the implementation of the SWMU 211-A EISB RA project. The implementation of the EISB RA project entails drilling of jet fracturing wells, injection wells, MWs, and preparation and injection of bioamendments. Previous investigations and process knowledge indicate that elevated levels of radiological contamination and VOCs may be present at the SWMU 211-A location.

This WMP addresses the specific management of wastes generated during the performance of the EISB RA project from generation through final disposition. All waste generated also will be managed according to the most recent revision of the *Four Rivers Nuclear Partnership, LLC Paducah Deactivation and Remediation Project Waste Management Plan*, CP2-WM-0001.

The major activities associated with this SWMU 211-A EISB RA project are listed below.

- Drilling to install:
  - Performance MWs
  - Long-term MWs
  - Jet injection borings
  - Biological amendment injection wells
- Fracturing operations [including injection of any of the following (jet injection)]:
  - Guar gum
  - Sand
  - ZVI
  - Deoxygenated water
- Biological amendment mixing and injection operations
  - Vegetable oil and water emulsion
  - *Dehalococcoides* bacteria
- MW sampling
- Decontamination operations

A copy of the WMP (electronic or hard copy) will be available on-site during execution of the EISB RA. The Waste Management Coordinator will be responsible for daily oversight of waste management activities and for ensuring compliance with this WMP.

This WMP emphasizes the following objectives.

- Manage the waste(s) in a manner that is protective of human health and the environment.

- Minimize waste generation, as feasible, thereby reducing unnecessary costs (analytical, storage, disposal, etc.).

- Select appropriate storage and/or disposal methods for generated waste(s).

All waste management activities must comply with this WMP, applicable contractor procedures, and *Waste Acceptance Criteria for the Treatment, Storage and Disposal Facilities at the Paducah U.S. Department of Energy Site*, CP2-WM-0011 (WAC), for on-site treatment, storage, and disposal facilities that may be

designated to receive EISB RA project waste. Off-site disposal of CERCLA-generated waste must comply with the CERCLA Off-Site Rule.

During the course of the EISB RA project, additional contractor and DOE waste management requirements may be identified. If necessary, revisions will be made to the WMP to ensure project compliance.

12.2 TYPES AND MANAGEMENT OF REMEDIATION WASTE, SAMPLE RESIDUALS, AND MISCELLANEOUS WASTE

A variety of remediation waste is expected to be generated during the EISB RA project. All waste generated has the potential to contain contaminants related to known or suspected past operational or disposal practices. Waste generated during remedial activities may include materials such as soil, concrete, PPE, plastic, sampling residuals and returns, sampling equipment, wastewater, sediment and mud from wastewater treatment, filter media, filter bags/cloths, purge and development wastewater.

The waste generated from field-related activities of this EISB RA project has the potential to contain contaminants related to past operations. Waste that is likely to have either hazardous or radiological contamination typically will be stored on-site in containers within the CERCLA waste storage areas in accordance with CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*, during the characterization period and prior to treatment/disposal.

The activities that are performed as part of the EISB RA project will produce the waste materials covered by this WMP and include the following:

- Drill cuttings/Soil
- Well development water
- Guar gum and ZVI mixtures (solids)
- Personnel protective equipment
- Contaminated debris and concrete cores
- Noncontaminated debris and construction waste
- Guard rail steel and concrete (foundation)
- Mud from decontamination and water treatment (soil)

Brief descriptions of each expected waste stream are outlined in the following sections.

12.2.1 Drill Cuttings/Soil

Drilling cuttings will be generated from installation of the new wells. It is assumed that all drill cuttings will have a 30% swell factor. An estimated total of this waste that is expected to be generated is listed in Section 12.2.8. Waste soil will be segregated from other waste to facilitate waste characterization at the conclusion of the EISB RA project activities. Soil will be containerized in appropriate containers.

12.2.2 Personal Protective Equipment

PPE will be worn as specified in JHAs, RWP, and other work control documents. While site personnel use procedures and BMPs to minimize opportunities for contacting TCE or Tc-99-contaminated media and equipment, it is likely that some PPE or related debris (e.g., plastic sheeting) will come into contact with TCE or Tc-99-contaminated materials during the remediation process. Process knowledge, visual inspections, radiological scanning, or direct sampling will be used to characterize PPE and any related debris. PPE also is characterized based on the primary waste (characterization data) that the PPE is

associated with in the activities performed. In some cases where material or PPE may have been volumetrically contaminated, direct sampling results are applied to the waste/PPE. Based on the results of the characterization, any PPE or related debris determined to be contaminated by a listed waste or exhibiting a RCRA characteristic will be managed as hazardous waste, decontaminated, or a no longer contaminated-with determination will be made.

12.2.3 Wastewater

Wastewater may be generated by well development activities, purge water, drilling activities, or decontamination or cleaning of equipment including bioamendment mixing equipment. The wastewater will be containerized and stored at on-site storage facilities. The water will be sampled and, if necessary, processed to remove sediment and then treated (e.g., C-612 Treatment Facility) as needed before it is discharged consistent with ARARs through an existing KPDES outfall or a CERCLA outfall or managed at an off-site wastewater treatment facility, if needed. The C-612 Treatment Facility was installed as part of a 1995 CERCLA interim ROD and utilizes air stripping for VOC contamination and ion exchange for removal of Tc-99. The treated water from the facility is released through the Paducah Site KPDES Outfall 001.

Wastewater will be generated during the installation and development of newly constructed MWs and when decontaminating the equipment used in performing the remedial operations. Aqueous environmental media waste contaminated with TCE will use a health-based concentration of 0.081 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES and/or CERCLA outfall. Section 12.3.1 provides information describing EPA's contained-in policy.

12.2.4 Guar Gum and ZVI Mixtures

ZVI, sand, and guar, along with an enzyme breaker, will be mixed and injected into the UCRS soils at locations where jet fracturing will be performed. Small excess quantities of the guar and ZVI are expected to be generated as part of this process from the cleaning of mixing and injection equipment, pumps, pipes, etc. This excess material will not be contaminated because they will not have been injected into the subsurface. The material will be containerized and disposed of appropriately. Because an enzyme breaker is added just before use, the guar portion of the mixture will degenerate over time leaving a water, sand, and iron mixture. Depending on its characteristics, the materials may require disposal or may be reused. Because typically it will be in the form of water emulsions with some solids, the material will be processed to separate the solids and liquids for disposal along with other solids and liquids generated by the action. This excess material will not be contaminated with VOCs, radioactive elements, or other contaminants since it will not have been in contact with the contaminated soil or groundwater.

12.2.5 Miscellaneous Noncontaminated Clean Trash

DOE has implemented waste management activities for the segregation of all clean trash (i.e., trash that is not chemically or radiologically contaminated). Examples of clean trash are packaging materials, glass bottles not used to store potentially hazardous chemicals, cardboard, plastic wrap. During implementation of this WMP, all clean trash will be segregated according to those guidelines and then collected and recycled or disposed of by the Project Waste Management Coordinator (PWMC), once it has been approved for removal.

12.2.6 Contaminated Debris and Concrete Cores

Infrastructure items that otherwise would interfere in performing EISB RA project activities will be removed, if possible. A metal vehicle guardrail bisects the areas to be treated. Removal of the guardrail and support posts will allow much more flexibility to align the drilling rigs for operations. The treatment area also is covered partially with concrete or asphalt pavement that will need to be cored to allow access to drill the subsurface. The guardrail and many of the coring locations are within a RAD control zone. As such, it is currently assumed these waste materials will be contaminated. These wastes will be containerized and characterized to determine if they meet the WAC of the C-746-U Landfill. Based on these characterization results, the waste will be dispositioned appropriately.

12.2.7 Waste Generation Estimate

A rough order of magnitude estimate of the quantity of waste expected to be generated during the performance of the SWMU 211-A RA project is shown below. The wastes are subdivided into expected waste types.

- Drill cuttings 1608 ft^3
- Decontamination wastewater 50,400 gal
- Well development and purge water 10,100 gal
- Guar gum and ZVI mixtures (solids) 5 ft^3
- Personnel protective equipment 225 ft^3
- Contaminated debris and concrete cores 37 ft^3
- Noncontaminated debris and construction waste 540 ft^3
- Contaminated guard rail steel and concrete (foundation) 270 ft^3
- Mud from decontamination and water treatment 178 ft^3

12.3 MANAGEMENT OF WASTE

EISB RA project activities may result in generation of the following waste:

- RCRA solid waste or hazardous waste (e.g., hazardous debris containing lead paint, metals considered RCRA Toxicity Characteristic waste, and/or RCRA Listed Wastes F001/F002/U228),

- Low-level radioactive waste,

- Mixed waste, and

- TSCA waste, as amended (PCB remediation soil waste).

All primary wastes (e.g., soil, sediment, sludge, removed waste materials) and secondary wastes (e.g., contaminated PPE, decontamination wastes) generated during the EISB RA project will serve as the point of generation and be characterized appropriately as RCRA (solid or hazardous waste), TSCA, low-level waste (LLW), and/or mixed wastes and managed accordingly. In many cases, debris generated from EISB RA project activities can result in heterogeneous waste streams. Characterization activities will focus on determining the overall average properties of the waste streams using both representative sampling and/or process/generator knowledge in accordance with state and federal regulations and approaches described in EPA preamble discussions contained in 57 *FR* 990 (Preamble to the Proposed Rule—Treatment Standards for Contaminated Debris, January 9, 1992). Any RCRA hazardous debris must be treated to meet LDR treatment standards for hazardous debris at 40 *CFR* § 268.45 prior to disposal.

12.3.1 Contained-In/Contaminated-With Determinations

Based on process knowledge of past operations at the SWMU 211-A and review of existing historic sampling data, waste streams (e.g., environmental media and debris contaminated by environmental media) generated during EISB RA project activities may be contaminated with listed hazardous waste [i.e., TCE, 1,1,1-trichloroethane (TCA)]. If either TCE and/or 1,1,1-TCA is determined to be present based on detectable concentrations of TCE and/or 1,1,1-TCA, the waste stream in question shall be managed as a RCRA hazardous waste per the contained-in policy until such time the waste stream is determined no longer to contain the listed hazardous waste. Waste generated from soil borings and well installations (i.e., drilling cuttings, purge water, sample residuals) with detectable TCE and/or 1,1,1-TCA will be classified as RCRA-listed hazardous wastes with waste codes F001, F002, and U228, if analytical results for the associated soil samples and water samples are above the health-based levels discussed in Table 6. Contaminated debris and environmental media is no longer considered to contain hazardous waste when (1) they no longer exhibit a characteristic of hazardous waste, and (2) concentrations of the listed hazardous constituents are below health-based levels. Sampling, process knowledge, or a combination of both may be used to make such determinations. Kentucky Division of Waste Management and EPA Region 4 previously have approved site-specific, health-based levels for making no longer contained-in/contaminated-with determinations for environmental media and debris at the Paducah Site, with respect to TCE and 1,1,1-TCA. The health-based levels originally were approved by Kentucky Division of Waste Management in the 2003 Agreed Order. These same health-based levels subsequently were approved by EPA and Kentucky in the *Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2433&D2 (DOE 2019b). The approved health-based levels for TCE and 1,1,1-TCA that will be used for this project are shown in Table 6.

Table 6. Approved Health-Based Contaminant Levels for Solids and Aqueous Liquids

Listed Constituent	Solids	Aqueous Liquids
TCE	39.2 ppm	0.081 ppm
1,1,1-TCA	2,080 ppm	Not Applicable*

*Aqueous solutions that meet the health-based level for TCE also shall be deemed no longer to contain 1,1,1-TCA.

DOE shall be responsible for comparing characterization data and/or using process knowledge for the environmental media/debris streams suspected as being contaminated with TCE and/or 1,1,1-TCA to the approved health-based levels. If, based on DOE's comparison, the total detectable concentrations of TCE and/or 1,1,1-TCA are below the approved health-based levels, the waste stream will be deemed as not to contain or be contaminated-with a listed hazardous waste. Aqueous environmental media waste contaminated with TCE will use a health-based concentration of 0.081 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES and/or CERCLA outfall.

12.4 WASTE MANAGEMENT TRACKING RESPONSIBILITIES

Waste generated during the EISB RA project activities will require implementation of a comprehensive waste tracking system to maintain waste inventory. The tracking system will document waste container numbers and locations; waste description; generation date; sampling, treatment and disposal date; and disposal location. The Technical Services Organization includes the Waste Generator Services Group, Waste Transportation Group, and Waste Operations Group. The Waste Generator Services Group will maintain the tracking system and will maintain a waste inventory system such that all waste generated during the EISB RA project is tracked properly and identified. To prevent inappropriate disposal of waste, generation data and information necessary to determine the amount of contamination present will be

documented so that proper disposal methods can be implemented. Determination of the ultimate disposal method is the responsibility of the Waste Transportation Group and the SWMU 211-A EISB RA project PM.

For the RA at SWMU 211-A, a CERCLA staging area (CSA) at the worksite is utilized for temporary storage of waste containers during waste generation activities. Once containers have been filled, they will be transferred to a fenced CSA on-site for sampling and characterization of the waste (e.g., C-752-C or C-760). In the case of wastewater, those containers that are transferred to C-752-C for filtration of suspended solids, sampling, and characterization. Each container is tracked using a request for disposal; CP2-WM-0011, *Waste Acceptance Criteria for the Treatment, Storage, and Disposal Facilities at the Paducah U.S. Department of Energy Site*; Waste Item Container Logs; CP3-WM-3015, *Waste Packaging*; and entered into the site's Integrated Waste Tracking System. The storage areas are established and secured per CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*. Each CSA boundary is posted to restrict unauthorized access. The CSAs are patrolled by security personnel. All waste containers utilize an access limiting, Tamper Indicating Device to secure each container when further processing will not be performed prior to disposition.

The following are additional responsibilities of the Waste Generator Services Group.

- Ensure that waste storage areas are properly established, maintained, and closed in accordance with ARARs contained in the ROD (DOE 2012).

- Track and update waste inventory database and reports.

- Support project waste personnel in the selection of containers and in the segregation of wastes.

- Maintain waste container inventories.

- Coordinate with off-site disposal facilities on waste acceptance and disposal pricing and disposition.

The following information is included in the waste inventory database.

- Generation date
- Request for disposal (RFD) number
- Origin location
- Waste type
- Description
- Quantity
- Storage location

Additional support personnel who fall under the Technical Services Director and may support the EISB RA project are included below.

12.4.1 DOE Prime Contractor Project Waste Management Coordinator

The Project's Frontline Supervisor, Field Team Manager, or designee will assume responsibility of the PWMC to ensure that all waste management activities comply with contractor procedures, contractor requirements, and the WMP, as appropriate. Responsibilities of the PWMC include coordination of activities with field personnel, oversight of waste management operations, and maintenance of the waste management logbook that contains a complete history of generated waste and the current status of individual waste containers.

Additional responsibilities of the PWMC include the following:

- Generation and containerization of all project waste;
- Ensuring adequate containers are available at worksite by coordinating with Waste Operation group;
- Maintaining an adequate supply of labels;
- Interfacing with Waste Transportation and Waste Operations Groups for necessary support;
- Preparing RFDs;
- Preparing Waste Item Container Log (WICL) for each waste container;
- Ensuring waste containers are properly labeled;
- Coordinating waste transfers from field; and
- Providing field support for sampling of waste containers to characterize wastes.

12.4.2 DOE Prime Contractor Transportation Group and Waste Operations Group

The Waste Transportation Group and Waste Operations will ensure that procurement and inspection of equipment, material, or services critical for shipments of waste to off-site treatment, storage, and disposal facilities are conducted in accordance with procedure CP3-QA-2500, *Procurement, Inspection, and Management of Items Critical for Paducah Off-Site Waste Shipments*. Additionally, the PWMC will ensure that wastes expected to be disposed of at the C-746-U Landfill are packaged and managed according to the WAC.

Additional responsibilities of the Waste Transportation Group and Waste Operations Group include the following by individual group.

12.4.3 Waste Transportation Group

- Interface with necessary personnel.
- Provide subject matter experts to support project field activities when needed.
- Characterize and document project waste.
- Provide technical support associated with waste handling and segregation to project personnel.
- Prepare Sample Analysis Event Plans for the sampling of waste containers.
- Manifest off-site shipments of waste.
- Verify container packaging and labeling are U.S. Department of Transportation compliant.
- Confirm compliance with U.S. Department of Transportation, DOE Orders, and regulations.

12.4.4 Waste Operations Group

- Provide containers as requested to project location.
- Pick up and move waste containers to approved storage facility.
- Pick up and transport waste containers as needed for on-site movement.
- Assist project in waste handling as required.

12.5 REMEDIATION WASTE REQUEST FOR DISPOSAL, STORAGE, AND LABELING

12.5.1 Request for Disposal

All waste will be documented using Forms CP2-WM-0011 F02, *Request for Disposal*, and CP2-WM-0011 F03, *Request for Disposal RCRA Regulatory Codes-Attachment B* (if applicable), in accordance with the WAC.

The PWMC is responsible for initiating an RFD, identifying, and documenting the type and quantity of waste that will be generated.

Waste Transportation Group Waste Engineer(s) is responsible for reviewing and approving the waste stream prior to generating waste. In addition, the Waste Engineer(s) will determine the anticipated path to disposal of the waste, the on-site storage facility, and provide guidance in selecting a container.

After Waste Engineer approval, PWMC is responsible for processing RFD documentation to the Waste Generator Services Group for processing.

The Waste Generator Services Group will enter the RFD into the Waste Tracking System.

12.5.2 Waste Identification Container Log

The PWMC will document each container of waste on Form CP3-WM-3015 F01, *Waste Item Container Log*. The PWMC completes the form, filling in all information including, but not limited to, RFD number, description, volume, container type, container number.

After container is filled, the PWMC is responsible for processing WICL documentation to the Waste Generator Services Group for processing.

The Waste Generator Services Group will enter the container into the Waste Tracking System.

12.5.3 Labeling

The PWMC is responsible for labeling each container in accordance with the WAC and CP3-WM-3015, *Waste Packaging*.

12.5.4 Storage

Containers will be stored in an appropriate storage area set up by Waste Generator Services Group in accordance with CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*.

12.6 TRANSPORTATION AND STORAGE OF REMEDIATION WASTE

12.6.1 Transportation of Remediation Waste

Any remediation waste transferred or transported in commerce along public rights-of-way must be conducted in compliance with all applicable laws and regulations. These transportation requirements include provisions for proper packaging, labeling, marking, manifesting, recordkeeping, and placarding that must be complied with fully for shipment. In addition, CERCLA Section 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that complies with applicable federal and state laws and has been approved by EPA for acceptance of CERCLA waste (see the CERCLA "Off-Site Rule" at 40 *CFR* § 300.440 et seq.). The generation, packaging, transportation, and storage of waste on-site will be performed consistent with the applicable procedures as listed in Section 4, Table 2.

12.6.2 Storage of Remediation Waste

The WMES Waste Generator Services Group will establish and maintain an appropriate waste storage area for the EISB RA project in accordance with contractor procedure CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*.

12.6.3 Required Equipment

Equipment that will be used to move or handle waste must be inspected following procedure CP3-SM-0020, *Administrative Controls for Powered Industrial Trucks*. Equipment that does not pass this inspection will be tagged out-of-service until corrective actions have been completed and the equipment reinspected. Transportation of waste will require the use of forklift trucks, flatbed trailers, and flatbed trucks. A drum grabber will be mounted on the forklift to place drums onto pallets for transport.

12.6.4 Containerization and Transportation of Solid Remediation Waste

Solid waste must be containerized consistent with applicable procedures contained in Section 4, Table 2. Absorbent material will be added to the wastes; the quantity depends on potential free liquids and will be established by the Waste Transportation Group Waste Engineer and added under the supervision of the PWMC prior to transporting waste material to a treatment, storage, or disposal facility in accordance with CP3-WM-3015, *Waste Packaging*, and applicable state and federal regulations for waste going off-site.

12.6.5 Containerization and Transportation of Liquid Remediation Waste

Liquid waste must be containerized in containers in accordance with CP3-WM-3015, *Waste Packaging*, and applicable state and federal regulations for waste transportation.

12.7 SCREENING OF ANALYTICAL SAMPLES

In situ screenings of analytical samples are performed by RADCON personnel for radiation and radioactive contamination. Additional screenings are performed prior to samples being shipped off-site. Prior to shipping samples, analytical samples are surveyed in accordance with CP3-WM-3028, *Off-site Shipping*. Survey procedures CP3-RP-1109, *Radiation Contamination Control and Monitoring*; CP3-RP-1108, *Posting and Labeling*; and CP4-RP-1110, *Radiation Surveys*, are used to perform the various radiation and contamination surveys required.

12.8 REMEDIATION WASTE CHARACTERIZATION, SAMPLING, AND ANALYSIS

12.8.1 Remediation Waste Characterization

Sampling and analysis of all SWMU 211-A RA project waste shall comply with this Work Plan and the WAC. The waste will be segregated by borehole or operation and characterized. The potential COCs for this EISB RA project include radionuclides, PCBs, polycyclic aromatic hydrocarbons, VOCs, and metals. The PPE waste will be characterized based on analytical results of the samples used to characterize the soils. Since most PPE such as Tyvek coveralls, tape, inner gloves, booties, etc. will be used throughout the entire borehole, the most stringent waste classification based on analytical results will be applied to all PPE from a given borehole or operation.

For solid waste, the "20 times" rule may be used to determine if the waste is characteristically hazardous. If the total concentration of RCRA constituents is greater than 20 times the toxicity characteristic leachate procedure (TCLP) limits in 40 *CFR* § 261.24, then the waste initially will be considered characteristically hazardous and placed into RCRA storage until further TCLP analysis can be performed for complete analysis.

Characterization requirements and guidance are provided in the site WAC, CP3-WM-0437, *Waste Characterization and Profiling*, and CP3-WM-1037, *Generation and Temporary Storage of Waste Materials*. Tables 7 through 10 list the analytical testing methods that will be used for analysis. The Waste Transportation Group will coordinate with the SWMU 211-A RA project PM and SMO for required analyses and guidance on collection and transfer of waste characterization samples to a fixed-base laboratory that participates in DOE Consolidated Audit Program (DOECAP).

Table 7. TCLP Parameters for Analysis of Solid Waste

Constituent	Method	TCLP Regulatory Limit (mg/L)	20 Times TCLP Regulatory Limit (mg/kg)
1,1-Dichloroethene	8260	0.7	14
1,2-Dichloroethane	8260	0.5	10
Arsenic	6010/6020	5.0	100
Barium	6010/6020	100.0	2,000
Benzene	8260	0.5	10
Cadmium	6010/6020	1.0	20
Carbon tetrachloride	8260	0.5	10
Chlordane	8081	0.03	0.6
Chlorobenzene	8260	100.0	2,000
Chloroform	8260	6.0	120
Chromium	6010/6020	5.0	100
Lead	6010/6020	5.0	100
Mercury	7470	0.2	4
Methyl ethyl ketone	8260	200.0	4,000
Selenium	6010/6020	1.0	20
Silver	6010/6020	5.0	100
Tetrachloroethene	8260	0.7	14
Trichloroethene	8260	0.5	10
Vinyl chloride	8260	0.2	4

Table 8. Analytical Parameters for Radiological and PCB Characterization

Constituent	Method
Total Uranium	Mass Spec
Uranium-234	Mass Spec
Uranium-235	Mass Spec
Uranium-238	Mass Spec
Americium-241	Alpha Spec
Neptunium-237	Alpha Spec
Plutonium-239/240	Alpha Spec
Plutonium-238	Alpha Spec
Thorium-228/232	Alpha Spec
Thorium-230	Alpha Spec
Technetium-99	Liquid Scintillation
Cesium-137	Gamma Spec
PCB	8082

Table 9. Waste Characterization Requirements for Solid Waste

Constituent	Method
TCLP VOCs	SW-846 1311, 8260
TCLP metals	SW-846 1311, 6010/6020/7470
Acetone	8260
Toluene	8260

Table 10. Waste Characterization Requirements for Decontamination, Development, and Purge Water

Parameter	Method	Detection Limit
TCE	EPA 624.1	0.001 mg/L
1,1,1-TCA	EPA 624.1	0.001 mg/L
PCBs	EPA 608.3	varies by Aroclor
Technetium-99	Liquid Scintillation	25 pCi/L
Total recoverable metals*	EPA 200.8/245.2	varies by metal
Total suspended solids	EPA 160.2	30 mg/L

*Total recoverable metals: antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, nickel, calcium, silver, tantalum, uranium, zinc, and mercury.

12.8.2 Waste Sampling and Analysis Plan

Wastes generated from sites designated as potentially contaminated will be characterized to classify the waste for proper handling, recordkeeping, transfer, storage, and disposal. Waste analyses will be performed using EPA-approved procedures, as applicable. Analyses required for hazardous waste classification will reference EPA SW-846 or other EPA-approved methods. QA/QC requirements and data management requirements, as specified in Chapter 10 of this document, will be followed for waste characterization sampling activities.

12.8.2.1 Waste Classification

Waste characterization sampling will be performed in accordance with procedure CP3-WM-0437, *Waste Characterization and Profiling*. Based on sample analyses, existing data, and/or process knowledge, the waste may be classified into one of the following categories.

- RCRA listed hazardous waste
- RCRA characteristic hazardous waste
- PCB waste
- Transuranic waste (TRU) LLW
- Mixed waste or
- Nonhazardous solid waste

12.8.2.1.1 RCRA-listed hazardous waste

Based on process knowledge and existing historical sample data, generation of RCRA-listed hazardous waste is expected on this project due to the presence of TCE and/or 1,1,1-TCA. Environmental releases of listed waste sources from SWMU 211-A have resulted in contamination of environmental media and debris, including subsurface soils and groundwater. Waste generated from soil borings and well installations (i.e., drilling cuttings, purge water, sample residuals) with detectable TCE and/or 1,1,1-TCA will be classified as RCRA-listed hazardous wastes with waste codes F001, F002, and U228, if analytical results for the associated soil samples and water samples are above the health-based levels discussed in Table 6. If the concentrations are below the levels contained in Table 6, then the waste will be deemed not to contain or

not to be contaminated-with a RCRA listed waste (based on TCE/TCA content). If the WAC is met, the waste will be disposed of properly in the C-746-U Landfill.

Aqueous environmental media waste contaminated with TCE will use a health-based concentration of 0.081 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES and/or CERCLA outfall.

12.8.2.1.2 RCRA-characteristic hazardous waste

Based on process knowledge and/or existing historical sample data, generation of RCRA characteristic-hazardous waste is possible during this EISB RA project.

12.8.2.1.3 PCB waste

Based on process knowledge generation of PCB-contaminated waste is possible on this project.

12.8.2.1.4 TRU waste

TRU wastes are those that are contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium, that are in concentrations greater than 100 nCi/g. Although it is possible that TRU elements may be detected in characterization samples collected on this project, it is unlikely that any of the waste generated will be at or above the TRU threshold limit. If TRU waste is generated in performing this work, the waste will be managed in accordance with DOE prime contractor procedures.

12.8.2.1.5 Low-level waste

LLWs is defined by Section 2021b of the Low-Level Radioactive Waste Policy Act of 1980 and the Low-level Radioactive Waste Policy Amendments Act of 1985 as radioactive material that—

A. Is not high-level radioactive waste, spent nuclear fuel, or byproduct material; and

B. The Nuclear Regulatory Commission, consistent with existing law and in accordance with paragraph A, classifies as low-level radioactive waste.

See also 10 *CFR* §§ 20.1003 and 61.2 (Nuclear Regulatory Commission definition of waste and low-level radioactive waste).

12.8.2.1.6 Mixed wastes

Mixed waste contains both hazardous waste and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954. The generation of mixed waste is possible on this project.

12.8.2.1.7 Nonhazardous wastes

Waste that does not meet the classification requirements of RCRA hazardous wastes, PCB wastes, LLW, TRU waste, or mixed wastes will be classified as nonhazardous solid waste. Nonhazardous solid waste will be generated as part of this project. The types of materials expected to be nonhazardous solid wastes are construction debris, waste concrete, grout, shipping materials, and containers (e.g., boxes, bags).

Wastes generated from sites designated as potentially contaminated will be characterized to classify the waste for proper handling, recordkeeping, transfer, storage, and disposal. Waste analyses will be performed

using the EPA-approved procedures, as applicable. Analyses required for hazardous waste classification will reference EPA SW-846 or other EPA-approved methods. QA/QC requirements and data management requirements will be followed for waste characterization sampling activities. Characterization requirements and guidance are provided in the site WAC and CP3-WM-0437, *Waste Characterization and Profiling*. The Waste Transportation Group will coordinate with the SWMU 211-A RA project PM and SMO for required analyses and guidance on collection and transfer of characterization samples to a fixed-base laboratory that participates in DOECAP.

12.8.2.2 Sampling remediation waste

12.8.2.2.1 SWMU 211-A RA project sampling team

The EISB RA project sampling team must coordinate closely with the PWMC concerning daily drilling and operational locations and types. The PWMC will contact the Waste Operations Manager or designee and have waste containers delivered to the sampling location.

12.8.2.2.2 Waste sampling operations

When necessary, the PWMC will be responsible for interfacing with the SWMU 211-A RA project sampling team to schedule characterization sampling of waste for on-site disposal. The sampling team will complete all chain-of-custody forms, and the sampling team is responsible for packaging and submitting samples to the contracted laboratory.

12.8.2.2.3 Remediation waste segregation

To facilitate waste characterization each PPE and waste will be segregated until analytical results are obtained or process knowledge is available. Using the analytical results and/or process knowledge, the appropriate waste classification will be applied to all PPE and waste soil or other waste generated. As feasible, soil waste and PPE will be segregated and bagged to facilitate storage of the materials while awaiting final disposition. Each bag of waste will be labeled with the key information such as boring number, date, potentially applicable sample numbers, etc. PPE and plastic also will be placed in an appropriate container.

12.8.2.2.4 Container labeling and identification

Each waste stream (soil, PPE and plastic, etc.) will be tracked and labeled with the RFD (form CP2-WM-0011 F02, “Request for Disposal”) system. All containers of a single waste stream will be tracked under the same RFD number and each container’s contents represented on a WICL (form CP3-WM-3015 F01). Containers will be labeled per the WAC.

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APPENDIX

QUALITY ASSURANCE PROJECT PLAN

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CONTENTS

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LIST OF QAPP WORKSHEETS

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ACRONYMS

A	analytical
AA	atomic absorption
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	certified for construction
COPC	chemical (or radionuclide) of potential concern
CRQL	contract-required quantification limit
CSM	conceptual site model
DHC	*Dehalococcoides ethenogenes*
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQO	data quality objective
ECD	electron capture detector
EISB	enhanced *in situ* bioremediation
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FFS	focused feasibility study
FID	flame ionization detector
FIDLER	field instrument for detection of low energy radiation
FRNP	Four Rivers Nuclear Partnership, LLC
FSP	field sampling plan
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GPS	Global Positioning System
HSS&Q	Health, Safety, Support, and Quality
IDQTF	Intergovernmental Data Quality Task Force
KDEP	Kentucky Department for Environmental Protection
MCL	maximum contaminant level
MDL	method detection limit
MPC	measurement performance criteria
MS	matrix spike
MW	monitoring well
N/A	not applicable
NAL	no action level
OREIS	Oak Ridge Environmental Information System
PAH	polycyclic aromatic hydrocarbon
PAL	project action limit
PCB	polychlorinated biphenyl
PEGASIS	Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PM	project manager
P-QAPP	Programmatic Quality Assurance Project Plan
PQL	practical quantitation limit
PQO	project quality objective
PT	proficiency testing
QA	quality assurance
QC	quality control

RAWP	remedial action work plan
RCT	radiological control technician
RDR	remedial design report
RG	remediation goal
RGA	Regional Gravel Aquifer
RMD	Risk Methods Document
RPD	relative percent difference
S	sampling
S&A	sampling and analytical
SAP	sampling and analysis plan
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TBD	to be determined
TOC	total organic carbon
TPD	training position description
TSA	technical systems audit
UCRS	Upper Continental Recharge System
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
VOA	volatile organic analyte
VOC	volatile organic compound
XRF	X-ray fluorescence

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

(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

Site Name/Project Name: Paducah Gaseous Diffusion Plant (PGDP)/Enhanced *In Situ* Bioremediation for Volatile Organic Sources to the Southwest Groundwater Plume at SWMU 211-A
Site Location: Paducah, Kentucky
Site Number/Code: KY8890008982
Contractor Name: Four Rivers Nuclear Partnership, LLC (FRNP)
Contractor Number: Contract No. DE-EM0004895
Contract Title: Paducah Gaseous Diffusion Plant Paducah Deactivation and Remediation Project
Work Assignment Number: *(to be added)*

Document Title: *Quality Assurance Project Plan for Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2/R1, September 2021.

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

Preparer's Name and Organizational Affiliation: Four Rivers Nuclear Partnership, LLC (FRNP) Bryan Clayton

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Preparer's Address, Telephone Number, and E-mail Address: 5511 Hobbs Road, Kevil, KY, 42053, Phone (270) 441-5412, bryan.clayton@pad.pppo.gov

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Preparation Date (Month/Year): 12/2019
Document Control Number: DOE/LX/07-2443&D2/R1

FRNP Environmental Services Director	BRUCE FORD (Affiliate) Digitally signed by BRUCE FORD (Affiliate) Date: 2021.11.01 11:35:49 -04'00' Signature Bruce Ford	Date:_____
FRNP Project Manager	BRYAN CLAYTON (Affiliate) Digitally signed by BRYAN CLAYTON (Affiliate) Date: 2021.11.01 10:27:22 -05'00' Signature Bryan Clayton	Date:_____
FRNP Environmental Monitoring and Sample Management Office Project Manager	LISA CRABTREE (Affiliate) Digitally signed by LISA CRABTREE (Affiliate) Date: 2021.11.01 11:40:10 -05'00' Signature Lisa Crabtree	Date:_____
FRNP Quality Assurance/ Quality Control Program Manager	JENNIE FREELS (Affiliate) Digitally signed by JENNIE FREELS (Affiliate) Date: 2021.11.01 10:52:45 -05'00' Signature Jennie Freels	Date:_____

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 Worksheets*, 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.
   - Intergovernmental Data Quality Task Force, March 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP QAPP Worksheets*.
   - *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *Volume 1. Human Health*, DOE/LX/07-0107&D2/R12/V1, June 2021.
   - *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan,* DOE/LX/07-2459&D1, April 2021.
   - *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2435&D2, December 2019.

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707 (FFA)

3. Identify approval entities: DOE, U.S. Environmental Protection Agency (EPA) Region 4, and Kentucky Department for Environmental Protection (KDEP)

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

5. List dates of scoping sessions that were held: List dates of scoping sessions that were held: May 23, 2018, Solid Waste Management Unit (SWMU) 211-A and SWMU 211-B Options.

NOTE: The date above was the scoping meeting held for selecting the remedial action (RA) to be implemented at SWMU 211-A. The *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2435&D2, provides the approved Operation, Maintenance, and Environmental Monitoring Plan as Exhibit A. The Operations, Maintenance, and

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

Environmental Monitoring Plan, provides the approved sampling and analysis requirement for supporting the baseline sampling, performance of the bioremediation activities, and the long-term monitoring for assessing attainment of the remedial action objectives (RAOs) for the action.

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, DOE/LX/07-1269&D2/R1 (February 2013)	5/14/2013 5/20/2013
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-1269&D2/R2 (P–QAPP) (March 2015)	Not Applicable (N/A)
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2402&D1 (P–QAPP) (February 2016)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2409&D1 (P–QAPP) (February 2017)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2421&D1 (P–QAPP) (April 2018)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2439&D1 (P–QAPP) (April 2019)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2446&D1 (P–QAPP) (April 2020)	N/A

7. List organizational partners (stakeholders) and connection with lead organization:
   EPA Region 4 and KDEP – PGDP Federal Facility Agreement Parties

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

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

   If any of the elements and/or information is not applicable to the project, then indicate the omitted QAPP elements/information on Table 1.

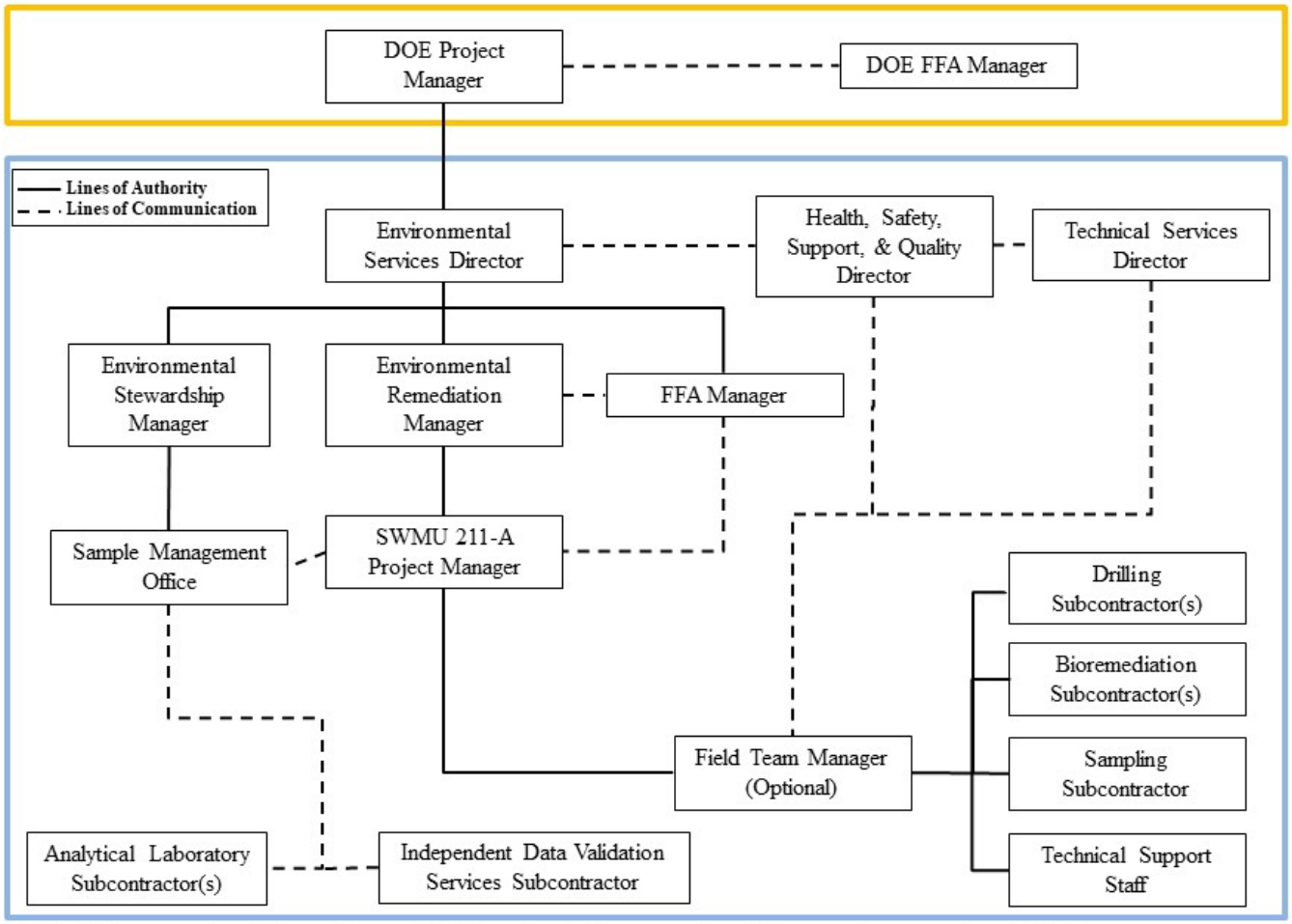
This QAPP includes all the combined worksheets that are required based on UFP-QAPP guidance, as updated by the optimized worksheet guidance (37 total worksheets). Each of these worksheets has been reviewed to ensure the accuracy of the information presented in this QAPP.

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
10	Conceptual Site Model	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 & 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
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
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 Requirements, Supplies, and Consumables
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

(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)



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

SWMU 211-A Remedial Action Organizational Chart

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

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
DOE FFA Manager	DOE	Tracey Duncan	(270) 441-6862	tracey.duncan@pppo.gov	2
DOE Project Manager (PM)	DOE	David Dollins	(270) 441-6819	dave.dollins@pppo.gov	3
Environmental Services Director	FRNP	Bruce Ford	(270) 441-5357	bruce.ford@pad.pppo.gov	4
Environmental Remediation Manager	FRNP	Joe Tarantino	(270) 441-5663	joe.tarantino@pad.pppo.gov	5
Environmental Stewardship Manager	FRNP	Bruce Ford (Acting)	(270) 441-5357	bruce.ford@pad.pppo.gov	6
SWMU 211-A Project Manager	FRNP	Bryan Clayton	(270) 441-5412	bryan.clayton@pad.pppo.gov	7
EPA FFA Manager	EPA	Victor Weeks	(404) 562-9189	weeks.victor@epa.gov	8
KDEP FFA Manager	KDEP	Brian Begley	(502) 564-6716	brian.begley@ky.gov	9
Kentucky PM	KDEP	To be determined (TBD)	TBD	TBD	10
EPA PM	EPA	Victor Weeks	(404) 562-8547	weeks.victor@epa.gov	11
FRNP FFA Manager	FRNP	LeAnne Garner	(270) 441-5436	leanne.garner@pad.pppo.gov	12
QA Program Manager	FRNP	Jennie Freels	(270) 441-5407	jennie.freels@pad.pppo.gov	13
Sample Management Office (SMO)	FRNP	Lisa Crabtree	(270) 441-5135	lisa.crabtree@pad.pppo.gov	14
Health, Safety, Security, and Quality (HSS&Q) Director	FRNP	Cynthia Williams	(270) 349-0109	cynthia.williams@pad.pppo.gov	15
SMO	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	16
Technical Services Director	FRNP	Jolie Fleming (Acting)	(270) 441-5912	jolie.fleming@pad.pppo.gov	17
Field Team Manager	FRNP	TBD	TBD	TBD	18
Contract Laboratory PM (Subcontractor)	TBD	TBD	TBD	TBD	19
Subcontractor PM (Sampling)	TBD	TBD	TBD	TBD	20
Subcontractor PM (Drilling)	TBD	TBD	TBD	TBD	21
Independent Data Validator Subcontractor	Wastren Advantage, Veolia Nuclear Solutions Federal Services	TBD	TBD	TBD	22

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

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. This change will not require a review by FFA stakeholders because it is not a substantive change. 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.

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

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

(UFP-QAPP Manual Sections 2.3.2–2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

This worksheet is used to identify key project personnel for each organization performing tasks defined in this QAPP. In this example, organizations include the prime contractor and laboratory. Add spaces for additional organizations and personnel as needed. This worksheet lists individual's project titles or roles; qualifications; and any specialized/nonroutine training, certifications, or clearances required by the project (e.g., explosives and ordnance disposal technician, professional engineer, certified professional geologist).

ORGANIZATION: Four Rivers Nuclear Partnership, LLC

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications**	Signature/Date*
Bruce Ford	Environmental Services Director, FRNP	> 4 years relevant work experience	No specialized training or certification. See Training Project Description (TPD).	
Joe Tarantino	Environmental Remediation Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Lisa Crabtree	Environmental Monitoring and SMO PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jaime Morrow	SMO Coordinator	> 4 years relevant work experience	No specialized training or certification. See TPD.	
TBD	Sample Team Leader, TBD	> 4 years relevant work experience	No specialized training or certification. See TPD.	
TBD	Drilling Contract PM, TBD	> 4 years relevant work experience	No specialized training or certification.	

ORGANIZATION: Laboratory

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

*Signature indicates personnel have read and agree to implement this QAPP as written and approved.
**Each position will have a training position description that is available at the FRNP Training Department.

QAPP Worksheet #6. Communication Pathways

(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

NOTE: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as telephone calls, e-mail, meetings, etc., will occur throughout the project. Regular project communication among DOE, the Prime Contractor, and the regulatory agencies concerning project progress is expected. Deviations from the work plan/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 PM: David Dollins; EPA Remedial PM: Victor Weeks; KDEP PM: TBD	david.dollins@pppo.gov victor.weeks@epa.gov	Communication among the FFA parties of DOE, EPA, and KDEP. (Pathway: e-mail and Groundwater Project Update conference calls Timing: as needed and scheduled Documentation: e-mail and letters)
Field progress reports	FRNP	FRNP Environmental Services Director: Bruce Ford	bruce.ford@pad.pppo.gov	Communication among the project staff, the site lead, and the DOE PM. (Pathway: e-mail and telephone Timing: as needed and scheduled Documentation: e-mail)
Stop work due to safety issues	FRNP	FRNP Environmental Services Director: Bruce Ford and FRNP HSS&Q Director: Cynthia Williams	bruce.ford@pad.pppo.gov cynthia.williams@pad.pppo.gov	FRNP will communicate work stoppages to DOE PM as required by procedure. (Pathway: e-mail and telephone Timing: as needed within two hours, Documentation: e-mail)
QAPP changes during project execution	FRNP	FRNP Environmental Services Director: Bruce Ford and FRNP QA/QC Program Manager: Jennie Freels	bruce.ford@pad.pppo.gov jennie.freels@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA. (Pathway: e-mail and telephone, Timing: as needed within 14 days, Documentation: letters)

QAPP Worksheet #6. Communication Pathways (Continued)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Field corrective actions	FRNP	Environmental Services Director: Bruce Ford	bruce.ford@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs. (Pathway: e-mail or telephone and hard copy Timing: as needed Documentation: Field Change Request Form)
Analytical laboratory interface	FRNP	SMO PM: Lisa Crabtree	lisa.crabtree@pad.pppo.gov	Communication between FRNP and analytical laboratory. (Pathway: e-mail and telephone Timing: as needed Documentation: e-mail)
Laboratory quality control variances	Contracted Laboratory	Laboratory PM	TBD	Notify FRNP SMO. SMO will notify FRNP PM to determine corrective actions. (Pathway: e-mail and telephone Timing: as needed within three days, Documentation: e-mail)
Analytical corrective actions	Contracted Laboratory, FRNP	Laboratory PM, SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Notify FRNP SMO. SMO will notify the FRNP PM. (Pathway: e-mail and telephone, Timing: as needed within three days, Documentation: e-mail and Corrective Action Plan)

QAPP Worksheet #6. Communication Pathways (Continued)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Data verification issues (e.g., incomplete records)	Veolia Nuclear Solutions Federal Services	Data Validator, SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Data verification issues will be reported to the FRNP SMO. (Pathway: e-mail and telephone, Timing: as needed within seven days, Documentation: e-mail and revised completed record)
Data validation issues (e.g., noncompliance with procedures)	Veolia Nuclear Solutions Federal Services	VNSFS Data Validator, SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Issues with data quality will be reported to the FRNP SMO. (Pathway: e-mail and telephone, Timing: as needed within three days, Documentation: e-mail and Corrective Action Plan)

NOTE: This QAPP worksheet 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

(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

Project scoping is the key to the success of any project and is part of the systematic planning process. A scoping meeting was held to develop the DQOs of the project. The scoping meeting identified the borings for the remedial design support investigation (RDSI) as well as the posttreatment sampling and analysis. The volatile organic compound (VOC) analytical soil data obtained during the RDSI provides the basis for the determining the treatment action. The scoping meeting held February 4, 2010, for the RDSI also supports this RA. The RDSI scope covered both the SWMU 1 area as well as the SWMUs at the C-720 Building included in the record of decision (ROD). This RA is limited to the SWMU 211-A area. A teleconference was held on May 23, 2018 for the FFA parties to determine whether the selected RA for SWMU 211-A would be Enhanced *In Situ* Bioremediation (EISB) with Interim land use controls (LUCs) or Long-Term Monitoring with Interim LUCs; EISB with Interim LUCs was selected. Following this teleconference, the *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2435&D2, (CFC RDR) was developed, and it contains the Operation, Maintenance, and Environmental Monitoring Plan for the EISB RA. The CFC RDR was approved by the FFA parties in December 2019.

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

Name of Project: EISB for SWMU 211-A
Date of Session: May 23, 2018
Scoping Session Purpose: Confirm the selection of the RA to be implemented as selected in the signed 2013 ROD. The confirmation of the selected alternative also confirms the use of the RAOs developed in the ROD.

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	DOE	Dollins, David	270-441-6819	dave.dollins@pppo.gov	Project Management
Project Manager	FRNP	Powers, Todd	270-441-5791	todd.powers@pad.pppo.gov	Project Management
FFA Manager	EPA	Corkran, Julie	404-562-8547	corkran.julie@epa.gov	Project Management
FFA Manager	KDEP	Begley, Brian	502-782-6317	brian.begley@ky.gov	Project Management
Project Manager	KDEP	Brewer, Gaye	270-898-8468	gaye.brewer@ky.gov	Technical Support
Technical Advisor	EPA	Ahsanuzzaman, Noman		ahsanuzzaman.noman@epa.gov	Technical Support
Technical Support	EPA	Bentkowski, Ben	404-562-8507	bentkowski.ben@epa.gov	Technical Support
Technical Support	DOE	Bonczek, Richard	859-219-4051	richard.bonczek@pppo.gov	Technical Support
Technical Support	Pro2Serve	Butterworth, George	270-441-6803	george.butterworthIII@pppo.gov	Technical Support
Technical Support	SMSI	Clauberg, Martin		martin.clauberg@pppo.gov	Technical Support
Technical Support	FRNP	Clayton, Bryan	270-441-5412	bryan.clayton@pad.pppo.gov	Technical Support
Technical Support	EPA	Davis, Eva	580-436-8548	davis.eva@epa.gov	Technical Support

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

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Technical Support	FRNP	Davis, Ken	270-441-5049	ken.davis@pad.pppo.gov	Technical Support
Technical Support	TechLaw	Dawson, Jana	703-627-0821	jdawson@techlawinc.com	Technical Support
Technical Support	FRNP	Fountain, Stefanie	270-441-5722	stefanie.fountain@pad.pppo.gov	Technical Support
Technical Support	KDEP	Jung, Christopher	502-782-6391	christopher.jung@ky.gov	Technical Support
Technical Support	TechLaw	McRae, Mac	678-493-1247	mmcrae@techlawinc.com	Technical Support
Technical Support	FRNP	Morgan, John	270-441-5206	john.morgan@pad.pppo.gov	Technical Support
Technical Support	FRNP	Miller, James	270-441-5068	james.miller@pad.pppo.gov	Technical Support
Technical Support	KDEP	Newton, Aaron	502-523-8023	aaron.newton@ky.gov	Technical Support
Technical Support	TechLaw	Rapal, Kristen	312-345-8929	kristen.rapal@techlawinc.com	Technical Support
Technical Support	Pro2Serve	Taylor, Tracy	270-441-6866	tracy.taylor@pppo.gov	Technical Support
Technical Support	FRNP	White, Jana	270-441-5185	jana.white@pad.pppo.gov	Technical Support

SMSI = Strategic Management Solutions, LLC

Decision Reached: The DOE determined as a result of the meeting that it would move forward with implementing the EISB with LUCs RA for SWMU 211-A.

QAPP Worksheet #10. Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

The site conceptual model is contained and discussed in Section 1.3 of this Remedial Action Work Plan (RAWP).

QAPP Worksheet #11. Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

Step 1: State the problem:

PGDP Southwest Plume consists of groundwater in the Regional Gravel Aquifer (RGA) contaminated primarily with trichloroethene. SWMU 211-A is a source of contamination to the Southwest Plume. A revised focused feasibility study (FFS) was performed for the Southwest Plume Upper Continental Recharge System (UCRS) source area. The following are the RAOs defined in the revised Southwest Plume FFS and the signed ROD:

(1) Treat and/or remove the principal threat waste consistent with the National Contingency Plan;

(2a) Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to excavation workers (< 10 ft);

(2b) Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending remedy selection as part of the Soils Operable Unit and the Groundwater Operable Unit;

(3) Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 Northeast and Southeast Sites so that contaminants migrating from the treatment areas do not result in the exceedance of maximum contaminant limits (MCLs) in the underlying RGA groundwater.

Soil remediation goals (RGs), volume-averaged UCRS soil concentrations that would meet RAO 3, were calculated in the revised Southwest Plume FFS, Appendix C, and also were included in Table 17 of the signed ROD. Table 17 contents are shown below.

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

Table 17. UCRS Soil Clean-up Levels for VOCs for Groundwater Protection and Worker Protection at the C-720 Area and the Oil Landfarm Source Areas

VOC	Half-Life (yr)	Basis for Cleanup Level—Primary MCL (mg/L)	UCRS Soil Cleanup Level (mg/kg)
C-720 Northeast and Southeast Sites			
TCE	50	5.00E-03	7.50E-02
1,1-DCE	infinite	7.00E-03	1.37E-01
cis-1,2-DCE	infinite	7.00E-02	6.19E-01
trans-1,2-DCE	infinite	1.00E-01	5.29E+00
Vinyl chloride	infinite	2.00E-03	5.70E-01
Oil Landfarm			
TCE	50	5.00E-03	7.30E-02
1,1-DCE	infinite	7.00E-03	1.30E-01
cis-1,2-DCE	infinite	7.00E-02	6.00E-01
trans -1,2-DCE	infinite	1.00E-01	1.08E+00
Vinyl chloride	infinite	2.00E-03	3.40E-02

EISB is not a remedial activity that results in instantaneous reduction of contaminant levels in the UCRS. As such, the measure of meeting the RAOs in the groundwater are attainment of MCLs in the RGA as measured in the Long-term groundwater monitoring system. Additionally, the biological reactions that occur in the subsurface require a specific range of subsurface conditions to be continuous. These conditions are measured via water samples obtained in monitoring and performance wells.

Step 2: Identify the Goals of the Study

The goals of the remedial action are to implement EISB with Interim LUCs to remove subsurface contamination using biological treatment that results in a decreased amount of contaminant mass available for migration to the RGA that allows the remedial action to attain the remedial action objectives (RAOs) as shown in Step 1. The monitoring of the EISB will allow the following to be determined:

- Status of the biological reactions occurring in the subsurface
- Status of RA in attaining RA goal #3.

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

Step 3. Identify Information Inputs:

The CFC RDR Section 4.2 and Appendix A (Operations, Maintenance, and Environmental Monitoring Plan) provide the critical parameters, ideal subsurface conditions for active bioremedial actions, and the necessary monitoring to assess and track the subsurface conditions. The collected groundwater samples and subsequent analytical results provide quantitative information for use in determining contamination levels in the groundwater and the geochemical conditions of the groundwater contained in the area being bioremediated. Appendix A of this RAWP provides the sampling and analysis requirements associated with the remedial action and also includes the necessary analytical methods. The sample analysis will be performed by one or more of the laboratories available through the Sample Management Office. (*Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2435&D2, December 2019.)

Step 4. Identify the Boundaries of the Study:

The geographical boundary is the SWMU 211-A treatment area, as determined in the May 23, 2018, planning session. The specific area is shown in Figure 9 of the CFC RDR. As indicated in Section 4.1 of this RAWP, the vertical boundaries for active treatment are 17 to 65 bgs within the UCRS. Because the groundwater flow in the UCRS is vertical, any shallow contaminants (< 17 ft BGS) will migrate vertically into the active treatment areas and be biodegraded. The CFC RDR Section 4.2 and Appendix A (Operations, Maintenance, and Environmental Monitoring Plan) and Section 3.2 of this RAWP provide the critical parameters, ideal subsurface conditions for active bioremedial actions, and identifies the necessary monitoring to assess and track the subsurface conditions. The temporal boundaries for the remedial action will continue until the FFA parties agree that the RAO has been attained or until the FFA parties agree the action has been completed. (*Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2435&D2, December 2019.)

Step 5. Develop the Analytical Approach:

- The samples will undergo chemical analysis at a contract laboratory, consistent with the contract protocols. Groundwater samples from performance monitoring wells will be utilized by the bioremediation specialist to determine if bioremedial activity is occurring and if subsurface conditions (both chemical and physical) are acceptable for the activity to continue or whether a maintenance activity is needed to improve the bioremedial performance of the treatment area. The CFC RDR Section 4.2 and Appendix A (Operations, Maintenance, and Environmental Monitoring Plan) and Section 3.2 of this RAWP provide the critical parameters, ideal subsurface conditions for active bioremedial actions, and the necessary monitoring to assess and track the subsurface conditions. Due to the multiple number of inputs/parameters that are utilized in assessing the subsurface conditions, simplistic if/then decisional analysis is not possible for this remedial action.

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

Groundwater samples and parameters from the Long-Term monitoring wells will be utilized in attaining the RAOs as set out in the ROD. The attainment of the RAOs are a decision that is arrived at by the FFA parties and not unilaterally developed.

Step 6. Specify Performance or Acceptance Criteria:

- The groundwater samples will be analyzed by a Sample Management Office laboratory utilizing the stated accepted method of analysis as stated in this QAPP and listed in CFC RDR Appendix A. Additionally, the analytical sample results must successfully undergo assessment and validation as indicated in this QAPP, allowing the data to be used to support the evaluation of the SWMU 211-A remedial action and support development of SWMU 211-A section of the PGDP CERCLA Five-Year Review Documents.

Step 7. Develop the Detailed Plan for Obtaining Data:

The design for collecting the needed data is identified in the CFC RDR. Specifically, Section 4.2 and Appendix A (Operations, Maintenance, and Environmental Monitoring Plan) and Section 3.2 of this RAWP provide the critical parameters, ideal subsurface conditions for active bioremedial actions, and identifies the necessary monitoring to assess and track the subsurface conditions. The information contained in the CFC RDR Appendix A Tables has been utilized to populate the worksheets in this QAPP, including Worksheets #19, #20, #24, #25, #26, #27, #28, and part of Worksheet #29.

QAPP Worksheet #12. Measurement Performance Criteria

(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

This worksheet documents the quantitative measurement performance criteria (MPC) in terms of precision, bias, and sensitivity for both field and laboratory measurements and is used to guide the selection of appropriate measurement techniques and analytical methods. MPC are developed to ensure collected data will satisfy the project quality objectives (PQOs) or DQOs documented on Worksheet #11. Example MPC include relative percent difference (RPD) comparisons and no target compounds greater than practical quantitation limit (PQL) or minimum detectable activity. A separate worksheet should be completed for each type of field or laboratory measurement. For analytical methods, MPC should be determined for each matrix, analyte, and concentration level. [Qualitative MPC (representativeness and comparability) should be addressed in the sample design, which is documented on Worksheet #17.] If MPC are analyte-specific, include this detail in a separate table or modify this worksheet as necessary. Example QAPP Worksheet #12 information is provided below, representing the currently used analytical methods. The listed methods have been reviewed to ensure that the criteria summarized below are aligned with those presented in the method. In the preparation of the project-specific QAPP, this information shall be confirmed. Changes in the method or laboratory can result in changes to these criteria.

Sampling will follow the referenced standard operating procedures. The following tables provide the measurement performance criteria.

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

Sampling of groundwater will follow the standard operating procedures (SOPs) included in this RAWP. The following table provides the measurement performance criteria.

Matrix	Groundwater
Analytical Group[1]	Volatile Organic Compounds (VOCs)
Concentration Level	Medium to High

Sampling Procedure[2]	**Analytical Method/SOP**[3]	**Data Quality Indicators**	**Measurement Performance Criteria**	**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-846-8260C See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[5]	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[4]	90%	Data Completeness Check	S&A

[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] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[5] 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 (Dissolved Hydrocarbon Gases, Water)

Sampling of groundwater will follow the SOPs included in this RAWP. The following table provides the measurement performance.

Matrix	Groundwater				
Analytical Group[1]	Dissolved Hydrocarbon Gases, (Methane, Ethane, Ethene, etc.)				
Concentration Level	Low to Medium				
Sampling Procedure[2]	**Analytical Method/SOP[3]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**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	RSK SOP 175 Modified See Worksheet #23	Precision—Lab	RPD—< 25%	Laboratory Duplicates	A
		Precision	RPD—< 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[5]	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[4]	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] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[5] 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-C. Measurement Performance Criteria (Total Organic Carbon)

Matrix	Groundwater				
Analytical Group[1]	Total Organic Carbon				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP[3]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**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-846-9060A See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[5]	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[4]	90%	Data Completeness Check	S&A

[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] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.
[5] 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-D. Measurement Performance Criteria (Dehalococcoides Bacteria)

Matrix	Groundwater				
Analytical Group[1]	Dehalococcoides Bacteria (Quantitative)				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**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	DHC by quantitative polymerase chain reaction See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data Completeness Check	S&A

[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] The most current version of the method the laboratory is accredited to perform will be used.
[5] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— 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 #13. Secondary Data Uses and Limitations

(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

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
Oak Ridge Environmental Information Systems (OREIS) Database	Various	Various	OREIS data will be used to provide data point(s) from which to measure the current status of groundwater near the treatment area.	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used.
Historical Documentation	Waste Area Grouping 27 RI Report, DOE/OR/07-1777&D2	DOE contractors, soil and water, 1998	Data will be used to provide a baseline data point(s) from which to measure the current status of groundwater near the treatment area.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.
Historical Documentation	Southwest Plume Site Investigation Report, DOE/OR/07-2180&D2/R1	DOE contractors, soil and water, 1997	Data will be used to provide a baseline data point(s) from which to measure the current status of groundwater near the treatment area.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.
Historical Documentation	*Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant*, DOE/LX/07-1288&D2/A1/R1	DOE contractors, soil and water, 2013 and 2015	Data will be used to provide a baseline data point(s) from which to measure the current status of groundwater near the treatment area.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.

NOTE; Oak Ridge Environmental Information System (OREIS) is the repository for environmental and waste characterization analytical results. OREIS is a limited access database. Most of the results in OREIS are downloaded to Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS) periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

QAPP Worksheets #14 and 16. Project Tasks & Schedule

(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization	FRNP	1st Quarter 2022	1st Quarter 2022	Field notes	TBD
DPT Jet Fracturing	FRNP Subcontractor	2nd Quarter 2022	3rd Quarter 2022	DPT Jet Injection Log	15-days after location completion
Injection Well Installation	FRNP Subcontractor	2nd Quarter 2022	3rd Quarter 2022	Well Completion Form (8043 Kentucky)	30-days after well completion
Long-term Monitoring Well Installation	FRNP Subcontractor	2nd Quarter 2022	3rd Quarter 2022	Well Completion Form (8043 Kentucky)	30-days after well completion
Baseline Water Sampling	FRNP Subcontractor	2nd Quarter 2022	2nd Quarter 2022	Chain-of-Custody	5-days after collection
Bioamendment Placement	FRNP Subcontractor	3rd Quarter 2022	3rd Quarter 2022	EVO Solution Injection Log	15-days after well location completion
Performance Monitoring Well Installation	FRNP Subcontractor	4th Quarter 2022	4th Quarter 2022	Well Completion Form (8043 Kentucky)	30-days after well completion
Sample collection	FRNP Subcontractor	2nd Quarter 2022	4th Quarter 2027*	Chain-of-Custody	5-days after collection
Analysis	Contract Lab	2nd Quarter 2022	4th Quarter 2027*	Report Analysis and Ready-to-Load Files	30-days after collection
Validation	Wastren Advantage, Inc.; Veolia Nuclear Solutions Federal Services	2nd Quarter 2022	4th Quarter 2027*	Validation summary	60-days after sample analysis completion
Data Report	Project Team	2nd Quarter 2022	1st Quarter 2023	Interim Remedial Action Completion Report+	March 30, 2023+

* Performance and Long-term monitoring is scheduled for a period of 5 years. The FFA members will determine the need for additional monitoring beyond the 5-year period. CERCLA will require a five-year review of the RA. Section 6 of this RAWP also provides the project-specific schedule of activities for this RA.

+ The Interim Remedial Action Completion Report will include postconstruction report elements and will be submitted in the near-term. A final Remedial Action Completion Report will be submitted in the future upon achievement of the long-term RAOs and remedial goals identified in the ROD for this SWMU.

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

(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

This worksheet should be completed for each matrix, analyte, analytical method, and concentration level (if applicable). Its purpose is to ensure the selected analytical laboratory and method can provide accurate data (i.e., quantitative results with known precision and bias) at the project action limit (PAL). During the systematic planning process, identify target analytes, PALs, and the reference limits (e.g., regulatory limits or risk-based limits) on which action limits are based. (If more than one set of reference limits is applicable, add additional columns.) Target analytes that are critical to project-specific decision-making should be highlighted. Next, determine the matrix-specific quantitation limit goal. The quantitation limit goal should be lower than the PAL by an amount determined by the DQOs/PQOs. This information, along with the MPC documented on Worksheet #12, should be used to select analytical methods and laboratories. Once the methods and laboratories have been selected, the remaining columns should be completed with laboratory-specific information. Project teams need to keep in mind that the laboratory-specific quantitation limit usually is determined in reagent water; therefore, the project quantitation limit goal (matrix-specific quantitation limit) will be higher. Explanations should be provided in cases where the quantitation limit is greater than either the project quantitation limit goal or the PAL. The laboratory must provide documentation that demonstrates precision and bias at the laboratory-specific quantitation limit. The laboratory-specific quantitation limit cannot be lower than the lowest calibration standard for any given method and analyte.

For the initially developed project-specific QAPP, the laboratory-specific columns should be filled out with target values to be used in laboratory solicitation and to support identification of the potential need to seek lower detection limits. The final laboratory-specific values will be populated and the project-specific QAPP updated once the laboratory has been contracted.

As part of the preparation of a project-specific QAPP, the PAL values should be updated with the most recent values or with project-specific values, as appropriate. As these values are updated, the P-QAPP will need to be updated accordingly.

Consideration also should be given to ecological values found in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *Volume 2*. *Ecological*, DOE/LX/07-0107&D2/R3/V2 (DOE 2019b).

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

Matrix: Groundwater
Analyte Group: VOCs

Analyte	Chemical Abstracts Service (CAS) Number	Project Action Limit/NAL (µg/kg)	Project Action Limit Reference*	Site Chemical or Radionuclide of Potential Concern (COPC)	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
1,1-Dichloroethene	75-35-4	7	MCL	Yes	2	0.3
cis-1,2-Dichloroethene	156-59-2	70	MCL	Yes	2	0.3
trans-1,2-Dichloroethene	156-60-5	100	MCL	Yes	2	0.3
Trichloroethene	79-01-6	5	MCL	Yes	2	0.3
Vinyl chloride	75-01-4	2	MCL	Yes	2	0.3

*This project does not have applicable groundwater cleanup levels, The Project Action Limits shown are groundwater protection RGs from Table 2.2 of Revised FFS. These groundwater protection RGs provided the basis for determining the UCRS soil cleanup levels applicable for this RA.

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

Matrix: Groundwater
Analytical Group: Dissolved Hydrocarbon Gases

Analyte	CAS Number	Project Action Limit/NAL (µg/L)*	Project Action Limit Reference*	Site COPC?	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
Methane	74-82-8	N/A	N/A	No	25	10
Ethene	74-85-1	N/A	N/A	No	25	10
Ethane	74-84-0	N/A	N/A	No	25	10

*This project does not have applicable groundwater cleanup levels. These analytes are used to evaluate the presence of biological reactions occurring in the subsurface.

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

Matrix: Groundwater
Analytical Group: Bacteria

Analyte	CAS Number	Project Action Limit/NAL (µg/L)*	Project Action Limit Reference*	Site COPC?	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
Dehalococcoides ethenogenes (DHC)	N/A	N/A	N/A	No	N/A	N/A

*This project does not have applicable groundwater cleanup levels. These analytes are used to evaluate the presence of biological reactions occurring in the subsurface.
Note: Laboratory will be required to have an Nuclear Regulatory Commission Radiological License.

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

Matrix: Groundwater
Analytical Group: Total Organic Carbon

Analyte	CAS Number	Project Action Limit/NAL (µg/L)*	Project Action Limit Reference*	Site COPC?	Laboratory-Specific	
					PQLs (mg/L)	MDLs (mg/L)
Total Organic Carbon	N/A	N/A	N/A	No	1	0.33

*This project does not have applicable groundwater cleanup levels. These analytes are used to evaluate the presence of biological reactions occurring in the subsurface.

QAPP Worksheet #17. Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, judgmental statistical approach):

The CFC RDR contains the judgmental design developed for the performance monitoring and long-term monitoring of the EISB Remedial Action. The use of a judgmental design provides the best fit for the intended purposes of the monitoring which are:

- Track the attainment of the RAOs that are not statistically based and that are provided in the ROD,* and
- Assess and track the bioremedial activity in the subsurface including the physical and geochemical conditions allowing bioremediation to continue as needed.

* Soil remediation goals, volume-averaged UCRS soil concentrations that would meet RAO 3, were calculated in the revised Southwest Plume FFS, Appendix C, and also were included in Table 17 of the signed ROD. Table 17 contents are shown below.

Table 17. UCRS Soil Clean-up Levels for VOCs for Groundwater Protection and Worker Protection at the C-720 Area and the Oil Landfarm Source Areas

VOC	Half-Life (yr)	Basis for Cleanup Level—Primary MCL (mg/L)	UCRS Soil Cleanup Level (mg/kg)
C-720 Northeast and Southeast Sites			
TCE	50	5.00E-03	7.50E-02
1,1-DCE	infinite	7.00E-03	1.37E-01
cis-1,2-DCE	infinite	7.00E-02	6.19E-01
trans-1,2-DCE	infinite	1.00E-01	5.29E+00
Vinyl chloride	infinite	2.00E-03	5.70E-01
Oil Landfarm			
TCE	50	5.00E-03	7.30E-02
1,1-DCE	infinite	7.00E-03	1.30E-01
cis-1,2-DCE	infinite	7.00E-02	6.00E-01
trans -1,2-DCE	infinite	1.00E-01	1.08E+00
Vinyl chloride	infinite	2.00E-03	3.40E-02

QAPP Worksheet #17. Sampling Design and Rationale (Continued)

The Performance Monitoring wells include 18 locations with nine wells each in the eastern and western portions of the treatment area. These wells are in nests of three, with monitoring to include the middle and lower UCRS and upper RGA. Because of the well locations being internal to the bioremediation treatment area, the wells provide the needed information to monitor the subsurface conditions and determine whether maintenance work is need in the treatment zone. The Long-term monitoring well network will include nine new wells plus one existing well. These wells are located outside of the treatment area and completed in the upper and middle RGA, which provide samples to assess the positive impacts on the RGA located beneath the treatment area.

The specifics concerned with the collection of these groundwater samples is contained in the Operations, Maintenance, and Environmental Monitoring Plan appended to the CFC RDR. In addition to the groundwater sampling and chemical analyses, radiological field scans, measurement and collection of field parameters will be performed as appropriate and as included in the remedial design report and associated operation, maintenance, and environmental monitoring plan. The temporal design of the sampling is designed to support the assessment of the remedial action for the first five years after bioamendment injections.

QAPP Worksheet #18. Sampling Locations and Methods

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)

Sample Location/ID	Geologic Unit	Reference Location to Treatment Area	Sample Depth	Matrix	Analyte/Analytical Group	Sampling SOP
Performance Monitoring Wells						
PW001	Upper RGA	West	67	Groundwater	VOC, Hydrocarbon Gases, TOC, DHC	CP4-ES-2101
PW002	Lower UCRS	West	57	Groundwater	VOC, Hydrocarbon Gases, TOC, DHC	CP4-ES-2101
PW003	Middle UCRS	West	47	Groundwater	VOC, Hydrocarbon Gases, TOC, DHC	CP4-ES-2101
PW004	Upper RGA	West	67	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW005	Lower UCRS	West	57	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW006	Middle UCRS	West	47	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW007	Upper RGA	West	67	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW008	Lower UCRS	West	57	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW009	Middle UCRS	West	47	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW010	Upper RGA	East	67	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW011	Lower UCRS	East	57	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW012	Middle UCRS	East	47	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW013	Upper RGA	East	67	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW014	Lower UCRS	East	57	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW015	Middle UCRS	East	47	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101

QAPP Worksheet #18. Sampling Locations and Methods (Continued)

Sample Location/ID	Geologic Unit	Reference Location to Treatment Area	Sample Depth	Matrix	Analyte/Analytical Group	Sampling SOP
Performance Monitoring Wells (Continued)						
PW016	Upper RGA	East	67	Groundwater	VOC, Hydrocarbon Gases, TOC	CP4-ES-2101
PW017	Lower UCRS	East	57	Groundwater	VOC, Hydrocarbon Gases, TOC, DHC	CP4-ES-2101
PW018	Middle UCRS	East	47	Groundwater	VOC, Hydrocarbon Gases, TOC, DHC	CP4-ES-2101
Long-Term Monitoring Wells						
MW575	Upper RGA	West	67	Groundwater	VOC	CP4-ES-2101
MW576	Middle RGA	West	72	Groundwater	VOC	CP4-ES-2101
MW577	Upper RGA	East	67	Groundwater	VOC	CP4-ES-2101
MW578	Middle RGA	East	72	Groundwater	VOC	CP4-ES-2101
MW579	Upper RGA	West	67	Groundwater	VOC	CP4-ES-2101
MW580	Middle RGA	West	72	Groundwater	VOC	CP4-ES-2101
MW581	Upper RGA	East	67	Groundwater	VOC	CP4-ES-2101
MW203	Middle RGA	East	73	Groundwater	VOC	CP4-ES-2101
MW582	Upper RGA	East	67	Groundwater	VOC	CP4-ES-2101
MW583	Middle RGA	East	72	Groundwater	VOC	CP4-ES-2101

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

(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: (To be Determined – Laboratory usage will be through Sample Management Office Laboratories under contract at the time of the sampling efforts.

List any required accreditations/certifications: DOE Consolidated Audit Program (DOECAP), if applicable.

Back-up Laboratory: N/A

Sample Delivery Method: Overnight delivery

Analytical Group	Matrix	Method/SOP Reference	Accreditation Expiration Date	Containers (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time, days	Data Package Turnaround Time
Volatile Organic Compounds	Groundwater	SW-846-8260C	TBD	3 × 40 mL Glass volatile organic analyte (VOA) vial	0-6°C, HCl to pH < 2, zero headspace	N/A	14	28
Dissolved Hydrocarbon Gases	Groundwater	RSK SOP 175 Modified	TBD	3 × 40 mL Glass VOA vial	0-6°C, HCl to pH < 2, zero headspace	N/A	14	28
Total Organic Carbon	Groundwater	SW-846-9060A	TBD	250 mL Amber glass	0-6°C, H2SO4 to pH < 2	N/A	28	28
DHC Bacteria	Groundwater	-	TBD	1L poly bottle with screw cap	Cool < 4°C	N/A	48 Hours	28

NOTE: Sample volume container requirements will be specified by the laboratory. Sample bottle requirements will be documented and relayed to the field sampling team via labels and chain-of-custody forms generated by PEMS (Paducah Project Environmental Measurements System).

QAPP Worksheet #20. Field QC Summary

(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Groundwater	VOCs	299	15	15	15	15	15	1 per cooler containing VOC or hydrocarbon gas samples	N/A	374
Groundwater	Dissolved Hydrocarbon Gases	216	11	11	11	11	11	1 per cooler containing VOC or hydrocarbon gas samples	N/A	271
Groundwater	Total Organic Carbon	204	11	11	11	11	11	N/A	N/A	259
Groundwater	DHC	50	3	N/A	N/A	N/A	N/A	N/A	N/A	53

QAPP Worksheet #21. Field SOPs

(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

Site-specific SOPs have been developed for site sampling activities. The following is a list of site sampling procedures that projects will select from for implementing sampling activities.

Reference Number	Title, Revision Date, and/or Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1.	CP4-ES-0043, *Temperature Control for Sample Storage* (12/19/2017)	Contractor	Sampling	N	N/A
2.	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System* (12/19/2017)	Contractor	N/A	N	None
3.	CP4-ES-2101, *Groundwater Sampling* (1/10/2018)	Contractor	Sampling	N	None
4.	CP4-ES-2100, *Groundwater Level Measurement* (1/2/2018)	Contractor	Sampling	N	N/A
5.	CP4-ES-2700, *Logbooks and Data Forms* (12/4/2017)	Contractor	N/A	N	None
6.	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (1/4/2018)	Contractor	Sampling	N	None
7.	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/2/2018)	Contractor	Sampling	N	None
8.	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* (12/12/2017)	Contractor	Sampling	N	None
9.	CP3-ES-5003, *Quality Assured Data* (1/9/2018	Contractor	N/A	N	None
10.	CP4-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling* (12/5/2017)	Contractor	N/A	N	None
11.	CP4-ES-5007, *Data Management Coordination* (12/7/2017)	Contractor	N/A	N	None

[a] SOPs are posted to the FRNP external website. External FFA parties can access this site using remote access with privileges upon approval. It is understood that SOPs are contractor specific. Additional procedure listings applicable to the fieldwork are listed in Section 4 of this RAWP.
[b] The work will be conducted by FRNP staff or a subcontractor. In either case, SOPs listed will be followed.
N/A = Not Applicable

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

(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

This worksheet should document procedures for calibrating, maintaining, testing, and/or inspecting field equipment (e.g., tools, pumps, gauges, magnetometers, pH meters, water-level measurement devices). If these activities are documented in an SOP or manufacturer's instructions, and the relevant SOP or instruction is attached, then the frequency, acceptance criteria, and corrective action columns may be left blank. Note that the information summarized in this worksheet should be recorded in the field notes/logs.

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
MiniRAE Photoionization Detector (PID) Toxic Gas Monitor with 10.5 eV Lamp or Similar Meter	Calibrate at the beginning of the day; check at the end of the day	As needed in the field; semiannually by the supplier	Measure known concentration of isobutylene 100 ppm (calibration gas)	Upon receipt, successful operation	Calibrate a.m., check p.m.	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Water Quality Meter	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	pH: ± 0.1 s.u. Specific Conductivity: ± 3% ORP: ± 10 mV DO: ± 0.3 mg/L Temp.: ± 0.3ºC	Recalibrate or service as necessary	Field Team Leader	Manufacturer's specifications

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

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Alpha Scintillator	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Geiger Mueller	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Gamma Scintillator or FIDLER	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Service by manufacturer	RCT Supervisor	Manufacturer's specifications
Field Equipment GPS	Daily check of known point beginning and end of each field day	Per manufacturer's specifications	Measure known control points and compare values	Upon receipt, successful operation	Beginning and end of each field day	Pass/Fail	Service by manufacturer	Field Team Leader	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*.
FIDLER = field instrument for detection of low energy radiation
GPS = Global Positioning System
RCT = radiological control technician

QAPP Worksheet #23. Analytical SOPs

(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SW-846-8260C	VOCs by GC/MS	Definitive	VOCs	GC-MS	TBD	TBD*
RSK SOP 175 Modified	Nonhalogenated Organics by GC	Definitive	Dissolved Hydrocarbon Gases	GC	TBD	TBD*
SW-846-9060A	Total Organic Carbon	Definitive	Total Organic Carbon	Carbonaceous Analyzer	TBD	TBD*
Census—TBD	Dehalcoccoides Bacteria	Screening	Bacteria	TBD	TBD	TBD*

*Information will be based on laboratory used. Laboratory will be chosen from available SMO laboratories prior to initiation of fieldwork.
GC/MS = gas chromatography/mass spectroscopy
TBD = to be determined

QAPP Worksheet #24. Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

Laboratories used by the DOE Prime Contractor are participants in DOE Consolidated Audit Program (DOECAP). In the fall of 2017, DOECAP began implementing accreditation 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 its QA Plan, including control charts established for 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.

Instrument*	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
*							

*The laboratory is responsible for maintaining instrument calibration information per their QA Plan, including control charts established for instrumentation. This information is audited. Additional certifications may be needed based on project-specific requirements (e.g., National Environmental Laboratory Accreditation Program, KDEP Drinking Water Laboratory Program). Field survey/sampling instrumentation will be calibrated according to manufacturer's instructions.

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

(UFP-QAPP Manual Section 3.2.3)
(EPA 2106-G-05 Section 2.3.6)

Laboratories used by the DOE Prime Contractor are participants in DOECAP. In the fall of 2017, DOECAP began implementing accreditation 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 its QA Plan, including control charts established for instrumentation. If the project has specific requirements that are different from those contained in the laboratory's quality manual, this table should be completed for those items.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
All	Per laboratory quality manual	QC standards	Per laboratory quality manual	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23

QAPP Worksheet #25. Analytical Instrument and Equipment Maintenance, Testing, and Inspection (Continued)

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	Electron capture detector (ECD)/flame ionization detector (FID) 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

ECD = electron capture device
FID = flame ionization detector

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

(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Section 2.3.3)

Sampling Organization: FRNP

Laboratory: TBD
Method of sample delivery (shipper/carrier): Overnight
Number of days from reporting until sample disposal: Six months (182 days)

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 CP3-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 CP3-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 CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Shipping coordination	SMO/DOE Prime Contractor	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
Sample receipt, inspection, & log-in	Sample Management/Contracted Laboratory	TBD
Sample custody and storage	Sample Management/Contracted Laboratory	TBD
Sample disposal	Sample Management/Contracted Laboratory	TBD

QAPP Worksheet #28. Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix: Groundwater
Analytical Group/Concentration Level: Volatile Organic Contaminants
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: TBD/FRNP
Analytical Organization: TBD
No. of Sample Locations: 30+

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 or hydrocarbon gas 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 plan CP2-ES-5105	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 plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

Worksheet #28. Analytical Quality Control and Corrective Action (Continued)

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-5105	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 samples	See data validation plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All samples, blanks, and QA samples	See data validation plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	Specific RPD defined in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plan CP2-ES-5105	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*

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

QAPP Worksheet #28. Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix: Groundwater
Analytical Group/Concentration Level: Dissolved Hydrocarbon Gases
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: TBD/FRNP
Analytical Organization: TBD
No. of Sample Locations: 30+

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 or hydrocarbon gas 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 plan CP2-ES-5105	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 plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

Worksheet #28. Analytical Quality Control and Corrective Action (Continued)

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-5105,	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	Specific RPD defined in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plan CP2-ES-5105	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*

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

QAPP Worksheet #28. Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix: Groundwater
Analytical Group/Concentration Level: Total Organic Carbon
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: TBD/FRNP
Analytical Organization: TBD
No. of Sample Locations: 30+

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*
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 plan CP2-ES-5105	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 plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

Worksheet #28. Analytical Quality Control and Corrective Action (Continued)

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 plan CP2-ES-5105	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	Specific RPD defined in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plan CP2-ES-5105	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*

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

QAPP Worksheet #29. Project Documents and Records

(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

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**
Data verification checklists	SMO/Data Validator	SMO	Project File
Data validation report	Data Validator	SMO	Project File
Data usability assessment report	Data Validator	SMO	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

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)

(EPA 2106-G-05 Section 2.4 and 2.5.5)

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Date	Assessment Deliverable	Deliverable Due Date
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Report	Per Individual Laboratory QA Manual
Field Assessments	Project Manager or Designated Representative	Quarterly	One per quarter	Assessment Report	15-days after performance of assessment

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
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Internal Audit Report Deficiency Memorandum	7 days following receipt of proficiency testing (PT) deficiency report and before analysis field samples	Laboratory Technical Director	QA/QC Program Manager/FRNP

QAPP Worksheet #34. Data Verification and Validation Inputs

(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	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. Data Verification and Validation Inputs (Continued)

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 PT 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

(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

This worksheet documents procedures that will be used to verify project data. It applies to both field and laboratory records. 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. As illustrated in the following example, verification often is performed at more than one step by more than one person.

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— SMO/FRNP
Data deliverables, analytes, and holding times	QAPP, contract, and procedures	The documentation from the contractual screening will be included in the data assessment packages, per DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*.	Laboratory PM/Contract Laboratory SMO/FRNP

QAPP Worksheet #35. Data Verification Procedures (Continued)

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Chain-of-custody, sample handling, sampling methods and procedures, and field transcription	QAPP, contract, and procedures	These items will be validated during the data assessment process as required by DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*, and CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans*. The documentation of this validation will be included in the data assessment packages.	SMO/FRNP
Analytical methods and procedures, laboratory data qualifiers, and standards	QAPP, contract, and procedures	These items will be reviewed during the data validation process as required by DOE Prime Contractor data validation procedures. Data validation will be performed in parallel with data assessment. The data validation report and data validation qualifiers will be considered when the data assessment process is being finalized.	Data Validation Subcontractor and SMO/FRNP
Audit reports, corrective action reports	QAPP and procedures	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	Contractor Performance Assurance Program Manager/FRNP
Deviations and qualifiers	QAPP and procedures	Any deviations and qualifiers resulting from process will be documented in the data assessment packages.	SMO/FRNP

QAPP Worksheet #36. Data Validation Procedures

(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Data Validator: Veolia Nuclear Solutions Federal Services

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator* (Title and Organizational Affiliation)
Step IIa/IIb	Solid (Concrete), Soil, and Groundwater	All	All	National Functional Guidelines; Worksheets #12, #15, and #28; and CP2-ES-0026, CP2-ES-0811, CP2-ES-5102 CP2-ES-5105, CP2-ES-5103, and CP2-ES-5107	Wastren Advantage, Inc.; Veolia Nuclear Solutions Federal Services

* Validation is to be conducted by a qualified individual, independent from sampling, laboratory, project management, or other decision making personnel for the task. This could be an outside party or someone within FRNP who is not involved in the project.

QAPP Worksheet #37. Data Usability Assessment

(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

The purpose of the project is to obtain groundwater samples from select areas within the SWMU 211-A. The samples collected then will be analyzed for potential contaminant concentrations.

FRNP will 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 PQOs documented in this work plan.

Summarize the usability assessment process and procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: 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 document any issues pertaining to the data and to indicate if DQOs of the project were met. The following plans are used for data validation: CP2-ES-0026 and CP2-ES-5105.

Describe the evaluative procedures used to assess overall measurement error associated with the project: Precision, accuracy, representativeness, comparability, completeness, and sensitivity parameters will be evaluated per procedure, CP3-ES-5003, *Quality Assured Data*. Consistent with procedure, CP3-ES-5003, data quality indicators are defined and described below.

Precision—A quantitative measurement of the variability of a group of measurements as compared to their average. Usually expressed as a percentage or a standard deviation, it evaluates the reproducibility of the system. Sample duplicates measure the reproducibility of the sampling event, while lab replicates measure the precision of the analytical process. The acceptable precision may be defined by the laboratory method used.

Accuracy—A quantitative measurement of the bias of the data. It represents how close the measurement data is to the true value. Sampling accuracy can be assessed by evaluating field and trip blanks. Analytical accuracy is measured by percent recoveries associated with the laboratory analytical control spikes (blank spikes), surrogate spikes, or matrix spikes. The acceptable accuracy may be defined by the laboratory method used.

Representativeness—A qualitative measurement of the ability of a sample or group of data to adequately describe or define the conditions being measured. Precision, accuracy, and completeness all affect representativeness. Sampling strategy (location, method, and frequency)

QAPP Worksheet #37. Data Usability Assessment (Continued)

is critical to assure that the samples statistically represent the population. Laboratory precision and accuracy reflect how representative the data is of the sample.

Completeness—A quantitative measurement of the percentage of acceptable data as compared to the number planned. Both sampling and analytical completeness can be measured.

Comparability—A qualitative measurement of the confidence with which one data set can be compared with another. Comparability is achieved by using standard techniques for collection and analysis.

Sensitivity—The sensitivity of analysis (or the detection limit) is determined by the analytical method, the laboratory analyst, and instrumentation.

The data quality indicators are calculated consistently with the methods discussed in Worksheet #12. The results are then compared to the Measurement Performance Criteria that are also included in Worksheet #12 for the applicable matrix and analytical group in order to identify exceedances of the specified criteria. The resulting 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 additional statistics used.

Identify the personnel responsible for performing the usability assessment:

Project Director: Bruce Ford
Project QA Manager: Jennie Freels
SMO: Lisa Crabtree
Risk Assessor: LeAnne Garner
Data Validator: Veolia Nuclear Solutions Federal Services
Field Team Leader: TBD (Optional)