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Remedial Action Work Plan for Phase IIa of the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Remedial Action Work Plan for Phase IIa of the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—October 2013

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-10CC40020

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CONTENTS

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FIGURES

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TABLES

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AHA	activity hazard assessment
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CQCP	construction quality control plan
CRZ	contamination reduction zone
CSM	conceptual site model
DMIP	Data Management Implementation Plan
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DPT	direct push technology
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERH	electrical resistance heating
EZ	exclusion zone
FCR	Field Change Request
FFA	Federal Facility Agreement
FS	Feasibility Study
GET	General Employee Training
GIS	geographic information system
GWOU	groundwater operable unit
HAP	hazardous air pollutant
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HP	health physics
HU	hydrogeologic unit
IM	intermodal
IRA	Interim Remedial Action
ISMS	Integrated Safety Management System
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
LDR	land disposal restriction
LLW	low-level waste
MCL	maximum contaminant limit
MCLG	maximum contaminant level goal
MIP	membrane interface probe
MPE	multiphase extraction
MSDS	material safety data sheet

MW	monitoring well
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
O&M	operations and maintenance
OREIS	Oak Ridge Environmental Information System
OSHA	Occupational Safety and Health Administration
PARCCS	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
PEMS	Paducah Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
POE	point of exposure
PM	project manager
ppb	parts per billion
PPE	personal protective equipment
PRG	preliminary remediation goal
PSS	plant shift superintendent
QA	quality assurance
QAPP	quality assurance project plan
QAPIP	quality assurance program and implementation plan
QC	quality control
RAD	radiological
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RCT	radiation control technician
RDR	remedial design report
RDSI	remedial design support investigation
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	record of decision
RPP	radiological protection program
RTL	Ready to Load
RWP	Radiological Work Permit
SAP	sampling and analysis plan
SMO	Sample Management Office
SOW	statement of work
SPH	six-phase heating
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
TSDF	treatment, storage, and disposal facility
UCRS	Upper Continental Recharge System
UIC	Underground Injection Control
U.S.C.	United States Code
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WMC	waste management coordinator
WMP	Waste Management Plan

EXECUTIVE SUMMARY

The response action selected in the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2/R2 (ROD), for the source area comprised of trichloroethene (TCE) and other volatile organic compounds (VOCs) found at the C-400 Cleaning Building area is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants from these areas that may present an imminent and substantial endangerment to public health and welfare (DOE 2005a). The releases resulted in a subsurface source zone of TCE and other VOCs at the south end of the C-400 Cleaning Building Area.

The Interim Remedial Action (IRA) includes the design, installation, operation, and subsequent decommissioning of an electrical resistance heating (ERH) system to heat discrete (vertical and horizontal) subsurface intervals of the subsurface source zone resulting in volatilization, removal, and recovery of VOCs from the C-400 treatment area. The remedial design report (RDR) established a phased deployment of ERH with the first phase (Phase I) having been completed in December 2010. Phase I implemented the design presented in the *Remedial Design Report, Certified for Construction Design Drawings and Technical Specifications Package, for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0005&D2/R1, referred to as the base design, in the southwest and east treatment areas of the C-400 Cleaning Building (DOE 2008a). In addition to removing VOCs from these areas, another important objective of Phase I was to evaluate the heating performance of the base design through the Regional Gravel Aquifer (RGA) down to the McNairy Formation interface in the southwest treatment area. Phase II requires the implementation of ERH technology near the southeast corner of the C-400 Cleaning Building and includes removal of contaminants from the southeast treatment area in both the Upper Continental Recharge System (UCRS) and RGA.

Based on the evaluation of the lessons learned from the Phase I operations and performance, it has been determined that, with minor adjustments to the base design, ERH will be utilized to remove VOCs in the UCRS and portions of the upper RGA. For purposes of defining the work for Phase IIa and in agreement with the Federal Facility Agreement parties, the ERH treatment depth will be approximately 20–60 ft below ground surface, which encompasses a portion of the UCRS and includes the upper RGA. Lessons learned, however, indicate that without extensive changes to the base design, ERH is not an effective technology to address VOCs in the lower RGA. Based on these conclusions, Phase II has been split into two separate actions: (1) a UCRS/upper RGA action (Phase IIa) and (2) a lower RGA action (Phase IIb). This Remedial Action Work Plan (RAWP) addresses implementation of Phase IIa, which defines only the changes related to the scope of activities and approaches that are necessary to implement the ERH technology in the C-400 southeast treatment area. This RAWP does not address remedial technology identification or implementation of pending actions for Phase IIb.

This RAWP provides project background information, presents a summary of remedial design support investigation results (completed August 2006), defines the project organization, and presents 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.

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1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located approximately 16.1 km (10 miles) west of Paducah, Kentucky, and 5.6 km (3.5 miles) south of the Ohio River in the western part of McCracken County, is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). Bordering the PGDP to the northeast, between the plant and the Ohio River, is the Tennessee Valley Authority Shawnee Steam Plant.

This Remedial Action Work Plan (RAWP) has been prepared for Phase IIa of the C-400 Cleaning Building Interim Remedial Action (IRA) at the PGDP. The IRA was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and is the response action selected in the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (ROD), DOE/OR/07-2150&D2/R2 (DOE 2005a).

The C-400 Cleaning Building is located inside the plant limited access area, near the center of the industrial section of PGDP. The building is bound by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively.

The IRA selected in the ROD is electrical resistance heating (ERH) technology. A phased deployment of ERH was implemented with the first phase (Phase I) having been completed in December 2010. Phase I implemented the design presented in the *Remedial Design Report, Certified for Construction Design Drawings and Technical Specifications Package, for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (RDR), DOE/LX/07-0005&D2/R1 (DOE 2008a). This is referred to as the base design and includes the southwest and east treatment areas of the C-400 Cleaning Building. In addition to removing volatile organic compounds (VOCs) from these areas, another important objective of Phase I was to evaluate the heating performance of the base design through the Regional Gravel Aquifer (RGA) down to the McNairy Formation interface in the southwest treatment area. Phase IIa requires the implementation of ERH technology near the southeast corner of the C-400 Cleaning Building and includes removal of contaminants from the southeast treatment area in both the Upper Continental Recharge System (UCRS) and upper RGA.

Based on the evaluation of lessons learned from the Phase I operations and performance, it has been determined that, with minor adjustments to the base design, ERH will be utilized to remove VOCs in the UCRS and portions of the upper RGA. For purposes of defining the work for Phase IIa and in agreement with the Federal Facility Agreement (FFA) parties, the ERH treatment depth will be approximately 20–60 ft below ground surface (bgs), which encompasses a portion of the UCRS and includes the upper RGA. Lessons learned, however, indicated that without extensive changes to the base design, ERH would not be an effective technology to address VOCs in the lower RGA. Based on these conclusions, Phase II has been split into two separate actions: (1) a UCRS/upper RGA action (Phase IIa) and (2) a lower RGA action (Phase IIb). This RAWP addresses implementation of Phase IIa. This RAWP does not address remedial technology identification or implementation of pending actions for Phase IIb. This RAWP defines only the changes related to the scope of activities and approaches that are necessary to implement the ERH technology for Phase IIa in the C-400 southeast treatment area (Figure 1).

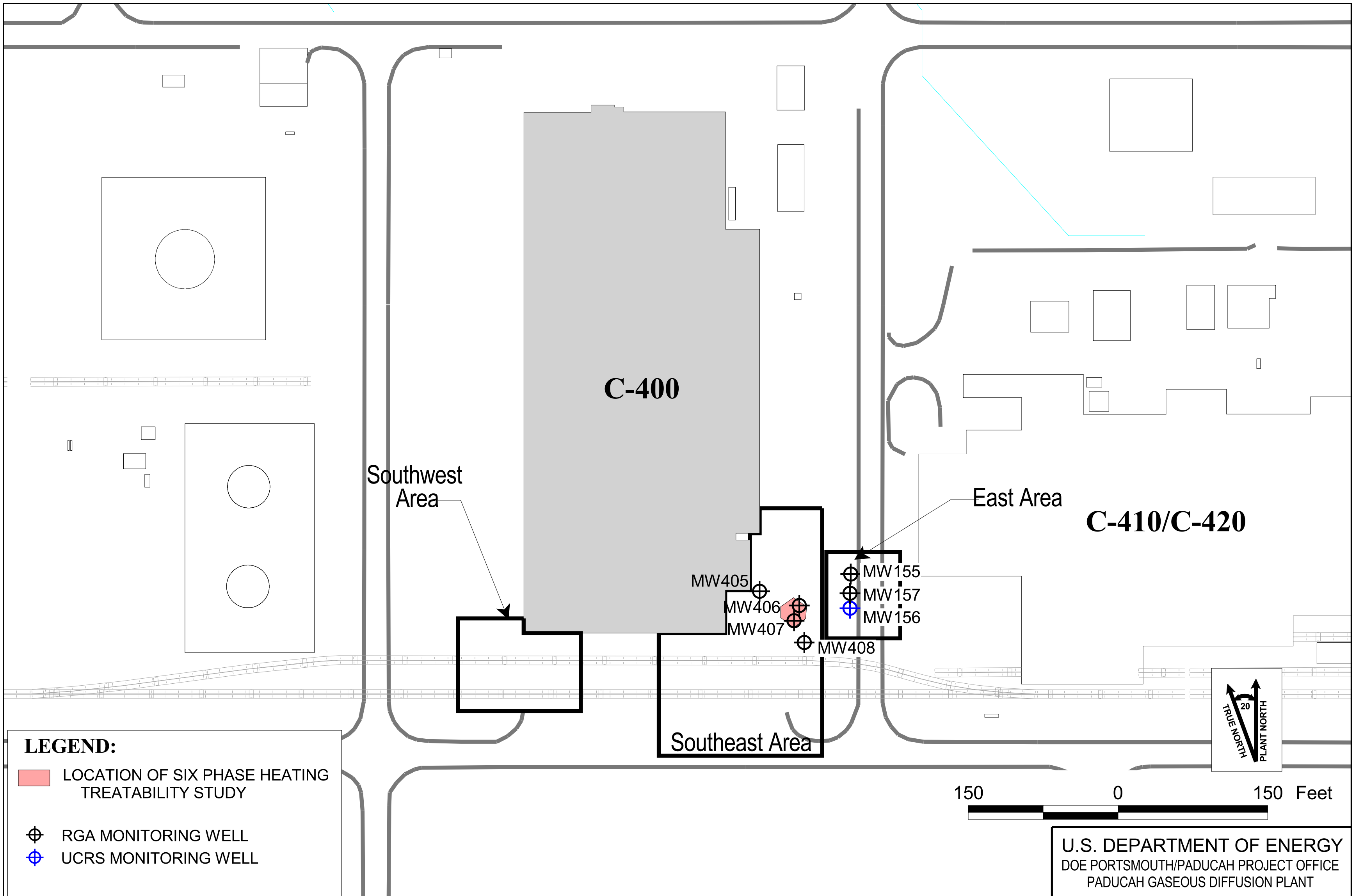

Figure 1. C-400 Area Layout

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1.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The PGDP, including the C-400 area, is underlain by a sequence of clay, silt, sand, and gravel layers deposited on limestone bedrock. The sediments above the limestone bedrock are grouped into three major stratigraphic units (loess, Continental Deposits, and McNairy Formation) and three major hydrogeologic units (HUs) (UCRS, RGA, and McNairy Flow System) as shown in Figure 2.

Across the PGDP site, the upper-most stratigraphic unit consists primarily of wind-deposited, silty clay, known as loess, extending from the surface to a depth of approximately 6.1 m (20 ft) bgs. Fill material, when present, is included in this unit. Beneath the loess, the Upper Continental Deposits, a subunit of the Continental Deposits consisting of discontinuous sand and gravel layers within a sequence of silts and clays, extends to an average depth of 19.8 m (65 ft) bgs. The Lower Continental Deposits, also a subunit of the Continental Deposits, is a highly permeable layer of gravelly sand or chert gravel, typically extending from approximately 19.8 to 28.0 m (65 to 92 ft) bgs. Below the Continental Deposits is the McNairy Formation, a sequence of silts, clays, and fine sands that extends from approximately 28.0 to 106.7 m (92 to 350 ft) bgs. These depths represent general conditions; depths vary at specific locations.

Groundwater flow through the loess and the Upper Continental Deposits is predominately downward into the Lower Continental Deposits. The groundwater flow system in the loess and the Upper Continental Deposits is called the UCRS. Groundwater flow in the Lower Continental Deposits is generally northward toward the Ohio River, although there is variability in groundwater flow as evidenced by the existence of the Northwest, Northeast, and Southwest Plumes. The groundwater flow system in the Lower Continental Deposits is called the RGA and constitutes the uppermost aquifer beneath PGDP and the adjacent area to the north.

The UCRS is subdivided into layers consisting of the loess and the Underlying Upper Continental Deposits. Sand and gravel lenses are separated from the underlying RGA by a 3.7- to 5.5-m (12- to 18-ft) thick silty or sandy clay in the UCRS. This aquitard reduces the vertical flow of groundwater from the sands and gravels unit to the gravels of the RGA. The RGA consists of a basal sand member of the Upper Continental Deposits and a thick, valley-fill deposit of sand and gravel of the Lower Continental Deposits. Below the RGA is the McNairy Flow System, which corresponds to the McNairy Formation. High contrast of hydraulic conductivity between the conductive Lower Continental Deposits and relatively nonconductive McNairy Formation limits flow between the Lower Continental Deposits and the McNairy. The middle portion of the McNairy Formation (the Levings Member, not shown in Figure 2) generally is considered an aquitard in the McNairy Flow System.

The depth of the shallow water table within the UCRS varies considerably across PGDP. In the C-400 area, ground covers (i.e., asphalt and concrete) and engineered drainage (i.e., storm sewers) limit rainfall infiltration. Many wells in the central and west areas of PGDP, including the C-400 area, define the site's water table trends. In monitoring well (MW)157, which monitors the water table near the southeast corner of C-400, the water table depth averages 9.4 m (31 ft).

The RGA potentiometric surface slopes to the north beneath PGDP. In the area of C-400, the depth of the RGA potentiometric surface is approximately 16.2 m (53 ft) bgs, as documented in the *Final Report Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2004).

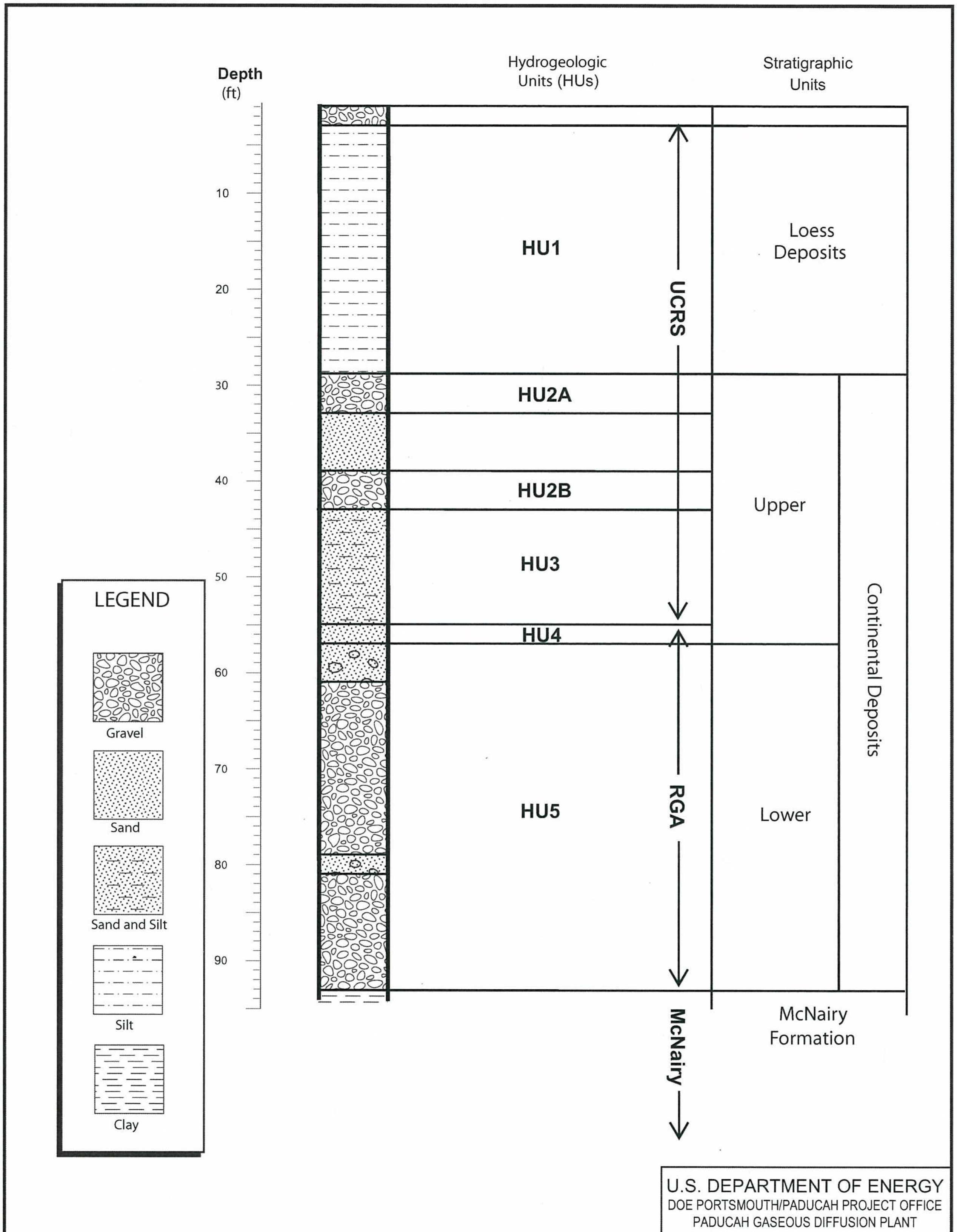

Figure 2. Stratigraphic and Hydrogeologic Units in Soil Boring H-007 of South C-400 Area

1.2 TREATMENT SITE LOCATION

Previous site investigations have identified three groundwater contaminant plumes resulting from past activities at PGDP. All three plumes are characterized by trichloroethene (TCE) contamination in the RGA. Two of these plumes, the Northwest and the Northeast Plumes, receive considerable contaminant loading from TCE source areas southeast and southwest of the C-400 Cleaning Building. The other groundwater plume, the Southwest Plume, is located west of the C-400 Building and south of the Northwest Plume. TCE and other VOCs from the C-400 Cleaning Building also contribute to the Southwest Plume.[1]

The Waste Area Grouping (WAG) 6 Remedial Investigation (RI), as well as other investigations and studies, characterized the nature and extent of contamination around the C-400 Building (DOE 1999). Sample analyses from the WAG 6 RI indicate that the primary site-related VOCs in the subsurface soil and groundwater in the C-400 Building area are TCE and its breakdown products (*trans*-1,2-dichloroethene (DCE), *cis*-1,2-DCE, and vinyl chloride) and 1,1-DCE. The WAG 6 RI concluded that there are zones of dense nonaqueous-phase liquid (DNAPL) TCE in the UCRS and RGA adjacent to and potentially beneath the C-400 Building. The *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (FS), DOE/OR/07-1857&D2, presents a summary of the characterization data for the C-400 area DNAPL zones and documents the DNAPL conceptual models for the area (DOE 2001).

The data from the WAG 6 RI, as well as other investigations and studies, indicate that DNAPL zones in the southeast area of the C-400 area account for the majority of the mass of DNAPL. TCE in several RGA groundwater wells and the collection of DNAPL from an RGA MW, MW408,[2] shown on Figure 1, demonstrate that DNAPL is located in the UCRS and extends into the RGA. As part of the WAG 6 RI, UCRS soil was characterized and shown to be a residual source of DNAPL.

Data from well clusters MW156 (upper RGA) and MW157 (UCRS), located near the southeast corner of C-400 (Figure 1), have demonstrated local TCE trends since 1991. Beginning in 1991 and continuing through 1995, dissolved TCE levels in the UCRS (MW157) and upper RGA (MW156) commonly exceeded 400,000 parts per billion (ppb). The TCE levels in the upper RGA had declined steadily to less than 10,000 ppb in 2006. Recent TCE trends in the UCRS are undocumented. MW157 (UCRS) last was sampled in 1997. The TCE analyses of MW156, in conjunction with TCE analyses from monitoring in other on-site PGDP MWs, establish the directions of the TCE plumes that map the dominant groundwater flow pathways. The primary groundwater flow direction passing through the southeast corner of C-400 is to the northwest (with the Northwest Plume).

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[1] The evidence for a C-400 source to the Southwest Plume is the presence of dissolved TCE and technetium-99 (Tc-99) groundwater contamination in the RGA, upgradient of the C-747 Contaminated Burial Yard. No other potential source is known. The hydraulic gradient at C-400 toward the Southwest Plume is slight. The predominant groundwater flow direction in the area south of C-400 is to the northwest.

[2] MW408 is a multiport well, capable of supporting low-flow sampling, but inadequate to provide any appreciable groundwater or DNAPL recovery. TCE trends in MW408 indicate that pooled DNAPL accumulated within the basal sample interval of MW408 (completed within the McNairy Formation) for a period of four months during the Six-Phase Heating Treatability Study. Subsequent sampling of the basal sampling port in MW408 has recovered TCE levels indicative of residual DNAPL occurrence.

1.3 REMEDIAL DESIGN SUPPORT INVESTIGATIONS

The purpose of the 2006 Remedial Design Support Investigation (RDSI) was to improve the ERH design by determining the subsurface soil conditions and the presence and relative concentration of VOCs in the UCRS, the RGA, and the RGA/Upper McNairy interface. The initial RDSI, conducted in accordance with *Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah Kentucky,* DOE/OR/07-2211&D2 was completed in August 2006, using membrane interface probe (MIP) technology (DOE 2005b).

During the RDSI, 18 MIP borings were completed through the UCRS to a depth of approximately 55 ft (16.7 m) bgs and 33 MIP borings were completed to the base of the RGA at an approximate depth of 100 ft (30.5 m) bgs. This plan optimized the location and depth of the MIP borings to complement the characterization data from the WAG 6 RI. Four of the 33 MIP borings completed to the base of the RGA were contingency borings completed to assess uncertainties within the RGA in accordance with the RDSI Characterization Plan.

MIP results from the RDSI were used to delineate the extent of TCE soil contamination. The results were critical in interpreting the distribution of TCE DNAPL and the topography of the base of the Continental Deposits south of the C-400 Building. These data characterized the three-dimensional aspects of the TCE DNAPL source zones and demonstrated that the residual TCE distribution was consistent with the conceptual model from the WAG 6 RI. Moreover, the data showed that the vertical extent of the DNAPL did not extend downward appreciably (0–1 ft) into the McNairy Formation below the primary RGA DNAPL pool at the base of the RGA.

The actual TCE mass removed during implementation of Phase I was substantially less than that originally estimated. Comparison of pretreatment and post treatment collocated samples from Phase I demonstrated that ERH was very effective in the removal of VOCs from the UCRS soils. The results of Phase I are reported in the *Technical Performance Evaluation for Phase I of the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1 (DOE 2011a). In the Phase I East Treatment Area, comparison of the baseline to the postoperational soil analyses shows a 95% reduction in TCE concentration, shifting the average concentration of 584 µg/kg to 29 µg/kg. For the Southwest Treatment Area, soil TCE concentrations were reduced 99%, shifting the average concentration of 1,046 µg/kg to 15 µg/kg. The mass of TCE recovered compared favorably to the RDR (DOE 2008a) estimate for the east treatment area, where the estimate was largely based on existing soil analyses. In the southwest treatment area, where the estimate was based primarily on the conceptual model, the quantity of TCE recovered was significantly less than the RDR (DOE 2008a) estimate; therefore, another sampling investigation was conducted to refine the estimate of mass in the Phase II treatment area.

The additional investigation was completed in April 2011. Soil and groundwater samples were collected from the Phase II southeast treatment area to provide data for reevaluation of the TCE mass estimate. Table 1 summarizes the field characterization activities that were completed for the TCE mass estimate. Two of the goals of the investigation were as follows:

1. Development of predictive relationships of previous and proposed MIP responses to current TCE concentrations, and

2. Assessment of the TCE DNAPL mass and volume within the C-400 Phase II treatment area.

The revised TCE volume and mass estimates are summarized in Section 1.5. Additional information regarding the predictive relationships and initial mass volume estimate approaches is included in the RDR

Appendix A: CD—*Remedial Design Report, Certified for Construction Design Drawings and Technical Specifications Package, for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0005&D2/R2 (DOE 2012).

Table 1. 2011 Sampling Activities in the Phase II Area to Support the TCE Volume Estimate

RDSI (2006) Boring ID	2011 MIP Boring ID	2011 Sample Boring ID	Samples for VOC Analysis						
			Soils				Groundwater		
			Horizons	Frequency	Depths (ft bgs)	# Samples	Horizons	Depths (ft bgs)	# Samples
MIP-13	MIP-53	SB53	UCRS/ McNairy	1	20-66, 71, 85, 94	52	RGA	70, 75, 80, 85, 90, 94	6
MIP-14	MIP-55	SB54	UCRS/ McNairy	2	20-54, 55, 95, 96	24	RGA	60, 65, 70, 80, 85, 90, 95	7
MIP-16	MIP-54	SB55	UCRS/ McNairy	1	5-45, 51-62, 94, 95	61	RGA	65, 70, 75, 80, 85, 90, 92	7
MIP-17	MIP-56	SB56	UCRS/ McNairy	2	20-64, 96, 96.3	27	RGA	70, 75, 80, 85, 90, 96	6
MIP-21	--	SB57	UCRS/ McNairy	2	20-54, 55, 85, 90, 95, 96	24	RGA	65, 69, 74, 80, 84, 89, 94	8
MIP-43	--	SB58	UCRS	2	20-62	24	--	--	--
MIP-44	--	SB60	UCRS	2	20-60, 61	25	--	--	--
MIP-48	--	SB59	UCRS/ McNairy	2	26-60, 61, 76, 91, 94, 95	29	RGA	65, 70, 75, 80, 85, 90, 93	8

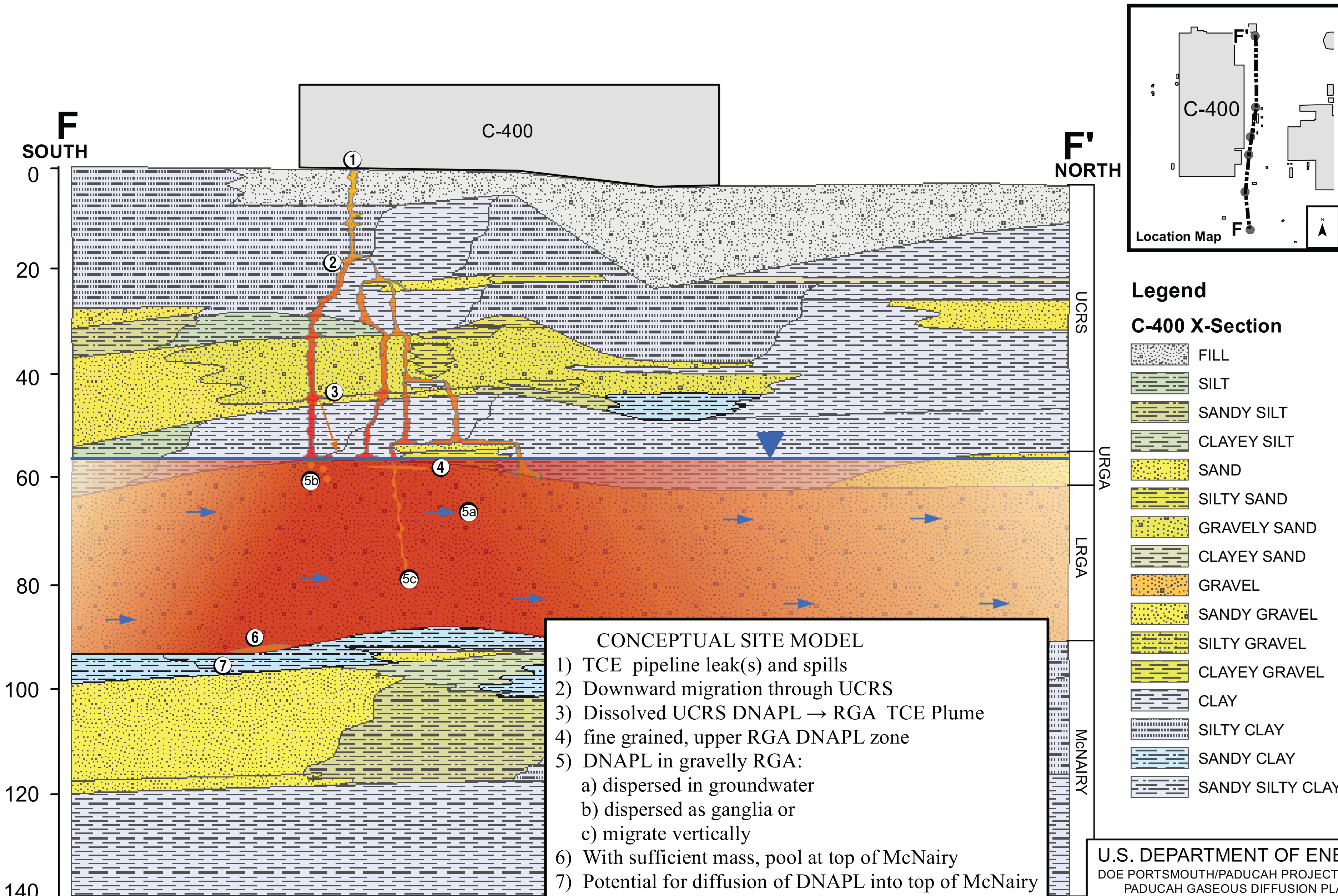
1.4 CONCEPTUAL SITE MODEL

The initial conceptual site model (CSM) developed during the remedial investigation for WAG 6 postulated a release from the TCE supply tank pipeline and additional loss at the loading area based on reported releases from C-400 sump pump discharges in 1970-1980. The initial assessment with process knowledge, but with limited data, anticipated significant quantities of TCE released to the environment. The six-phase heating treatability study (2003), in the vicinity of the pipeline leak, conducted ERH and removed an estimated 1,900 gal (≈ 23,000 lb at 12.2 lb per gal) of TCE. These data along with the MIP investigation resulted in an estimate of 75,000 gal (≈ 915,000 lb) of TCE in the subsurface in the vicinity of the southern part of C-400 (DOE 2008a).

This conceptual understanding then was modified with the implementation of the Phase I ERH, which recovered approximately 580 gal (≈ 7,000 lb) of TCE from the southwest and east areas within the UCRS.

An estimate, based on the CSM, anticipated approximately 23,000 gal (≈ 280,000 lb) of TCE in the Phase I areas. This discrepancy in mass led to the reevaluation and update of the CSM. The RDR discusses a further evaluation of the CSM including geologic structure, refining the mass estimate, and attempting to further understand the anticipated DNAPL (DOE 2012). The revised CSM then is used to help guide the decisions for remedial alternatives to address the contamination. Figure 3 provides a conceptualization of the CSM.

BACK
TABLE OF CONTENTS
FORWARD



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PADUCAH GASEOUS DIFFUSION PLANT

LATA Environmental Services of Kentucky, LLC

Figure 3. C-400 Conceptual Site Model Cross-section View

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1.5 DNAPL MASS ESTIMATE

DOE reevaluated the mass volume of the Phase II area based on the analyses of soil samples obtained during the field characterization effort conducted in early 2011 to refine the CSM. Three approaches were used to assess TCE mass volume for the treatment area and determined that a possible estimate of the range of TCE mass remaining in the Phase II treatment area is between 600 and 7,000 gal. The TCE mass volume estimate calculations are documented further in Appendix B of the RDR (DOE 2012). Summary findings are provided here. The lower end of the range of the estimate, 600 gal (7,300 lb), is based on soil and groundwater samples collected to date [including the WAG 6 RI, the Six-Phase Heating (SPH) Treatability Study, and additional data collected in 2011]. The higher end of the range of the estimate includes observation of TCE in groundwater and assumptions of potential DNAPL occurrence that, although not encountered in the samples collected to date, are considered to be representative of conditions based on the site conceptual model. These observations and assumptions include the following:

- Persistent TCE mass flux associated with the Northwest Plume (approximately 4,000 lb/330 gal per year for as long as 50 years),
- Past recovery of DNAPL from MW408, which is located in the Southeast treatment area, and
- The knowledge that DNAPL distribution in subsurface environments is typically heterogeneous and difficult to characterize using conventional sampling techniques.

A breakdown of DNAPL mass volume in the UCRS and RGA is as follows:

- For the interval 0 to 60 ft bgs, which is the UCRS and upper RGA, the estimate is 290 to 30,500 lb (24 to 2,500 gal).
- For the interval 60 to 100 ft bgs, which is the lower RGA, the estimate is 7,000 to 55,000 lb (576 to 4,500 gal).

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2. TREATMENT TECHNOLOGY

2.1 ELECTRICAL RESISTANCE HEATING DESCRIPTION

Phase IIa of the C-400 IRA includes the installation and operation of a three-phase ERH system to heat the subsurface, volatilize VOCs, and remove them by way of a vapor recovery system in the UCRS and upper RGA in the southeast treatment area. The three-phase ERH system consists primarily of a network of inground electrodes, vapor extraction wells, and vacuum monitoring piezometers distributed throughout the zone of UCRS/Upper RGA contamination shown in Figure 4. These vapors are collected by a vapor recovery system. In the process of VOC volatilization, steam also will be generated, which will facilitate the stripping of VOCs (primarily TCE and its breakdown products) from the treatment area. Three-phase heating is the preferred electrical phasing method for a large and noncircular remediation area such as that defined for the C-400 IRA. Electrical power for the electrodes will be supplied to the ERH system by an existing electrical feeder, 23B from the PGDP C-531-1 electrical switchyard.

The treatment system installation and operations will include the following activities:

- Installation of electrodes, vapor/liquid extraction wells, vacuum monitoring piezometers, and thermocouple arrays in the TCE source zone at the C-400 Cleaning Building area;
- Heating of subsurface soil, contaminants, and groundwater via application of electrical current to the UCRS and upper RGA soils;
- Withdrawal of volatilized VOCs (primarily TCE and its breakdown products) by high vacuum extraction;
- Extraction of a nominal quantity of groundwater to assist in controlling local gradients and groundwater migration;
- Treatment of contaminated groundwater/vapor through the use of an aboveground treatment system;
- Reinjection of treated groundwater at subsurface electrodes to maintain electrical conductivity and facilitate heat transfer;
- Monitoring of contaminants in recovered groundwater and vapor;
- Discharge of treated groundwater/condensate through Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 001;
- Discharge of treated vapors to the atmosphere and real-time monitoring of treated vapors; and
- Characterization of waste for on-site and off-site disposal.

2.2 APPLICABILITY TO THE PGDP SITE

As demonstrated in Phase I implementation, ERH is a technology suited for implementation in the unsaturated and saturated soils of the UCRS and in the underlying RGA. The applicability based on lessons learned from Phase I confirmed the implementation in the UCRS, but identified the applicability for the RGA to be limited only to the upper RGA soil. The upper RGA soil is defined in Section 8.

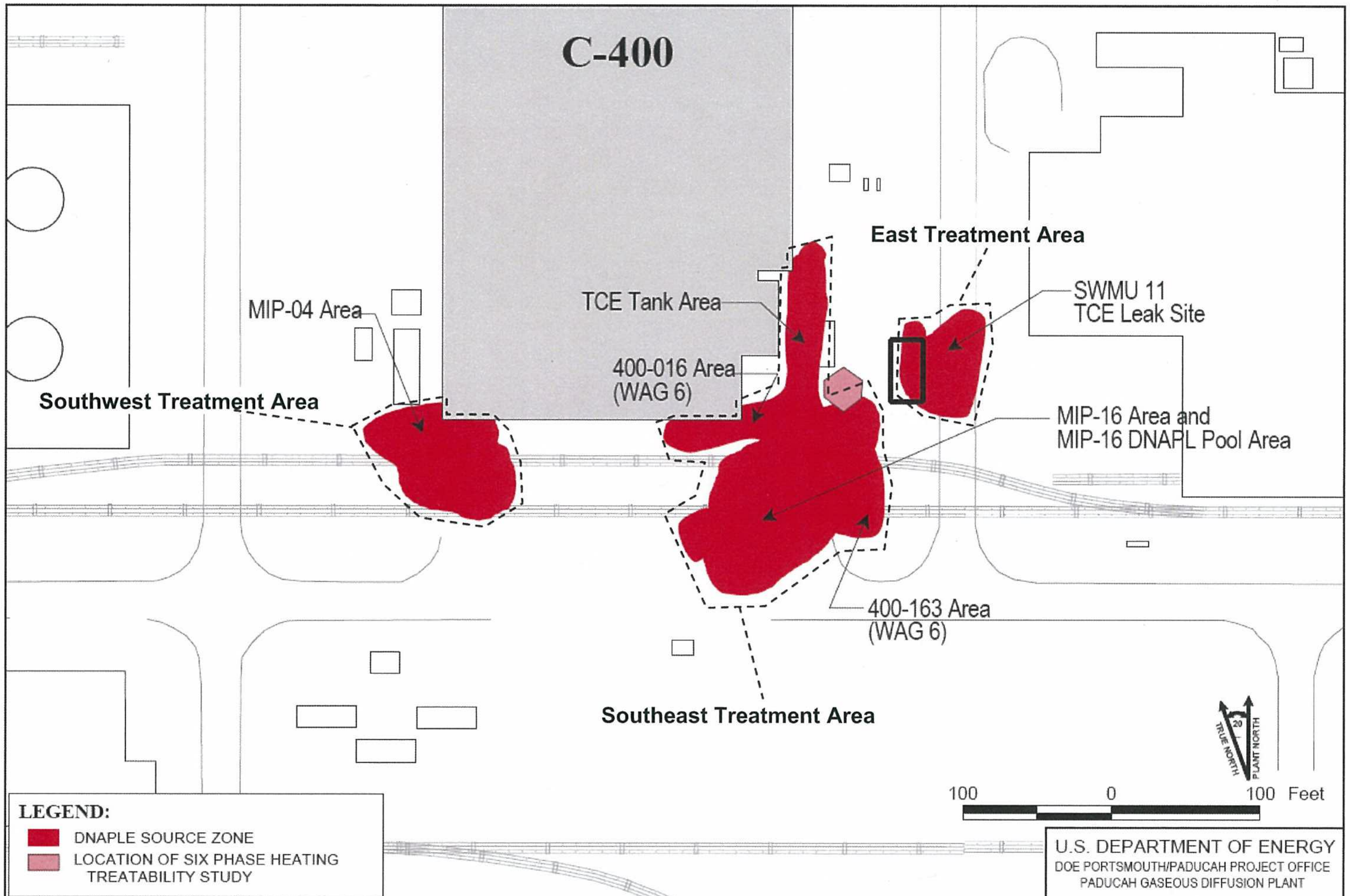

Figure 4. DNAPL Source Zone Delineations from RDSI and WAG 6 Results

Figure No. c5ac90005sk012R8.apr
DATE 11-28-07

Data presented in the *Technical Performance Evaluation for Phase I of the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, support the conclusion that remedial action objectives (RAOs), as documented in the ROD, were achieved for the UCRS and upper RGA in the Phase I treatment areas. Postoperational soil sample results show average percent reductions in TCE concentrations of 95% and 99% in the Phase I east and southwest treatment areas. Groundwater analytical results from postoperational samples show average reductions of 76% and 99% in the east and southwest areas, respectively. Refer to the technical performance evaluation for additional information.

2.3 PHASED DEPLOYMENT

Per the RDR, a phased deployment of ERH is being implemented. The first phase (Phase I) implemented the design presented in the RDR, referred to as the base design, in the southwest and east treatment areas (DOE 2008a). In addition to removing VOCs from these areas, another important objective of Phase I was to evaluate the heating performance of the base design through the RGA down to the McNairy Formation interface in the southwest treatment area. Treatment in the east treatment area involved only the UCRS. Lessons learned from Phase I have been evaluated and appropriate contingency actions were self-implemented in the revised RDR (DOE 2012). In addition to evaluating heating performance in the RGA, operation of Phase I also provided the opportunity to evaluate the radius of influence of the vapor recovery system, assess hydraulic containment, and optimize the aboveground vapor/liquid treatment system.

Based on the evaluation of the lessons learned from Phase I operations and performance, it has been determined that, with minor adjustments to the base design, ERH will be utilized to remove VOCs in the UCRS and upper RGA. Lessons learned, however, indicated that without extensive changes to the base design, ERH is not effective in the lower RGA. Based on these conclusions, Phase II has been split into two separate actions: (1) a UCRS/upper RGA action (Phase IIa) and (2) a lower RGA action (Phase IIb). This RAWP does not address Phase IIb.

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3. TREATMENT SYSTEM OBJECTIVES AND UNCERTAINTY MANAGEMENT

3.1 INTERIM REMEDIAL ACTION OBJECTIVES

The IRA objectives for the C-400 Cleaning Building, as defined by Section 2.8 of the ROD, are as follows:

- Prevent exposure to contaminated groundwater by on-site industrial workers through institutional controls (e.g., excavation/penetration permit program);
- Reduce VOC contamination (primarily TCE and it breakdown products) in UCRS soil at the C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure (POEs); and
- Reduce the extent and mass of the VOC source (primarily TCE and its breakdown products) in the upper RGA in the C-400 Cleaning Building area to reduce the migration of the VOC contamination to off-site POEs. The RAO for the lower RGA will be addressed by Phase IIb, which is not included in this RAWP.

The RDR presents the design of the treatment systems that address the IRA objectives (DOE 2012).

3.2 CRITERIA FOR CEASING IRA SYSTEM OPERATIONS

The remediation goal for this interim action, as stated in Section 2.9.3 of the ROD (DOE 2005a), is to operate ERH system "until monitoring indicates that heating has stabilized in the subsurface and that recovery of TCE, as measured in the recovered vapor, diminishes to a point at which further recovery is at a constant rate (i.e., recovery is asymptotic). At asymptosis, continued heating would not be expected to result in any further significant reduction of toxicity, mobility, or volume of the zone of contamination." In addition to the vapor concentration, extracted groundwater TCE concentrations will be evaluated as an indicator of when the point of diminishing returns is being approached in TCE mass recovery. Section 3.3 of the RDR defines asymptotic recovery in more detail and provides additional detail regarding criteria for ceasing ERH operations, including temperature stabilization requirements (DOE 2012).

3.3 UNCERTAINTY MANAGEMENT

Several uncertainties required management during the implementation of Phase I of the C-400 IRA. Phased deployment of the ERH technology for the C-400 IRA was the primary means used to manage these uncertainties. Phase I of the project, implemented in the southwest and east treatment areas, was completed in the fall of 2010. In addition to evaluating heating performance in the RGA, operation of Phase I also provided the opportunity to evaluate the radius of influence of the vapor recovery system, assess hydraulic containment, and optimize the aboveground vapor/liquid treatment system. Table 2 contains a review of the lessons learned and possible contingency actions identified before Phase I was initiated. Bold italicized text in Table 2 denotes updated information generated as a result of lessons learned from Phase I operations. Table 3 summarizes uncertainty management for Phase IIa of the project.

Table 2. Review of Phase I Lessons Learned and Possible Contingency Actions

Deviation	Cause of Deviation	Possible Contingency Actions to be Taken Prior to Phase II
Temperature levels not achieved ***Target temperatures were achieved in UCRS and upper RGA soils. Target temperatures were not achieved in the lower RGA. As a result, ERH will be deployed in the UCRS and upper RGA soils during Phase IIa. An alternative remedy or remedies better suited to conditions in the lower RGA will be identified for Phase IIb implementation.***	Higher than anticipated groundwater flow through treatment zone ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils.***	• Control groundwater flux through heated area with hydraulic control measures such as upgradient pumping. • Install a bank of electrodes upgradient of the treatment zone to preheat groundwater. • Install electrodes on a closer spacing. • Install electrodes into the McNairy Formation. • Reevaluate design of groundwater extraction system.
	Higher than anticipated soil resistivity ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils.***	• Inject electrolytic solution into the electrodes to increase soil conductivity. • Install electrodes on a closer spacing. • Increase diameter of electrode boring to allow more graphite/high conductivity material to be placed in the boring around an electrode. • Install graphite/high conductivity material around electrodes that are below the water table. • Size electrode wires for higher power levels at each electrode. • Operate electrodes at higher voltages, up to 347 volts, phase to neutral.
	Maintaining hydraulic and pneumatic control resulted in excessive extraction of energy ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils.***	• Reevaluate whether pneumatic control can be maintained at a lower vapor extraction rate. • Reevaluate whether hydraulic control can be maintained at a lower groundwater extraction rate. • Determine if higher power input to the electrodes is required.

Table 2. Review Phase I Lessons Learned and Possible Contingency Actions (Continued)

Deviation	Cause of Deviation	Possible Contingency Actions to be Taken Prior to Phase II
Ineffective capture of contaminants ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils; however, improvements to contaminant capture systems were identified.***	Groundwater extraction wells/pumps not effective at capturing contaminants ***Contaminant capture in groundwater was effective; however, improvements were identified.***	• Install more extraction wells or more closely spaced extraction wells. — ***Additional and more closely spaced multiphase wells are planned based on Phase I operating experience, although this is primarily to improve vapor capture, not groundwater capture.*** • Redesign extraction wells (groundwater portion) for improved radius of capture. — ***Changes to well screen and filter pack are planned based on Phase I operating experience, not because contaminant capture was determined to be ineffective, but rather due to infiltration of fines during pumping.*** • Increase capacity of extraction pumps. — ***No change in extraction well pump capacity is indicated or planned based on Phase I operating experience.*** • Redesign pumps to withstand higher temperatures or more aggressive chemical environment. — ***This contingency action is not necessary based on Phase I operating experience.***
	Vapor extraction wells not effective at capturing contaminants ***Contaminant capture via vapor extraction was effective; however, improvements were identified.***	• Install more extraction wells or more closely spaced extraction wells. — ***Additional multiphase wells are planned based on Phase I operating experience to improve vapor capture.*** • Redesign extraction wells (vapor extraction portion) for improved vapor capture. — ***Vapor screen and filter pack designs were modified to help minimize infiltration of fines.*** • Heat a larger vertical area (e.g., heat the entire zone from bottom of RGA to 18 ft bgs) in areas where only a portion of the vertical profile is heated. — ***No change indicated or planned for Phase IIa relative to this contingency action based on Phase I operating experience.*** • Increase capacity (e.g., vacuum, flow rate) of vacuum extraction pump(s). — ***This contingency action is being implemented for Phase II based on Phase I operating experience.*** • Reevaluate operation/design of vapor extraction wells above electrodes. — ***No change indicated or planned for Phase IIa relative to this contingency action based on Phase I operating experience.***

Table 2. Review Phase I Lessons Learned and Possible Contingency Actions (Continued)

Deviation	Cause of Deviation	Possible Contingency Actions to be Taken Prior to Phase II
	Treatment system not able to adequately handle contaminant levels ***Not observed to be a problem during Phase I heating.***	• Increase capacity of treatment system. — ***No increase in treatment system capacity is indicated or planned relative to this contingency action based on Phase I operating experience.*** • Redesign treatment system. — ***Although the treatment system was able to accommodate Phase I contaminant levels, changes are planned for the vapor treatment stream. The cryogenic condensation units will be replaced with a steam regenerated carbon adsorption system that is less complicated and less costly and operate.***
Hydraulic control not maintained ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils; however, improvements to contaminant capture systems were identified as indicated to the right.***	Groundwater flow higher than estimated	• Increase groundwater extraction capability (more wells, larger pumps, increased treatment capacity, more efficient well design). — ***Additional multiphase wells planned are indicated based on Phase I operating experience, although this is primarily to improve vapor capture, not groundwater capture.*** • Reduce gradient across heated zone through downgradient or perimeter injection. — ***No change indicated or planned relative to this contingency action based on Phase I operating experience.***
	Pumps not effective at extracting groundwater at high temperatures	• Redesign/reevaluate extraction pumps and other extraction equipment — ***No change indicated or planned relative to this contingency action based on Phase I operating experience.*** • Redesign groundwater extraction wells. — ***No change indicated or planned relative to this contingency action based on Phase I operating experience.***
	Groundwater extraction well design prevents adequate or effective extraction	• Redesign groundwater extraction wells. — ***Changes to well screen and filter pack are planned based on Phase I operating experience to reduce the infiltration of fines during pumping.***
Pneumatic control not maintained ***Not observed to be a problem during Phase I heating of UCRS and upper RGA soils; however, improvements to contaminant capture systems were identified as indicated to the right.***	Vapor extraction wells not effective at capturing contaminants	• Increase vapor extraction capability (more wells, larger vacuum pumps, increased treatment capacity, more efficient well design). — ***Additional multiphase wells are planned for Phase IIa to improve vapor capture based on Phase I operating experience.***
	Preferential flow from some areas resulted in minimal extraction from other areas	• Redesign controls on vapor extraction wells to allow more viable extraction rates or adjustments. — ***Vacuum blower capacity (vacuum levels and flow rate) is being evaluated for improvement based on Phase I operating experience.*** — ***Improvements are planned for Phase IIa for flow metering systems.***

Note: Bold italicized text denotes updated information generated as a result of lessons learned from Phase I operations.

BACK

TABLE OF CONTENTS

FORWARD

Table 3. Uncertainty Matrix for Phase IIa of the C-400 IRA

Expected Condition	Potential Deviation	Impact of Deviation	Contingency	Monitoring
Recoverable VOC source is appropriately estimated based on results of the RDSI and WAG 6 RI results.	VOC mass significantly over estimated.	Vapor treatment system over sized during design.	Design and install the vapor/liquid treatment system with the flexibility to accommodate a wide range of contaminant levels.	Routine monitoring of subsurface temperatures and TCE levels in recovered vapors and groundwater in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).
		Operational period may be less than the 180 to 240 days estimated.	Respond in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).	Monitor in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).
	VOC mass significantly under estimated.	Aboveground treatment system under sized during design such that it is not able to treat the VOC loading on recovered vapor and groundwater.	Alter heating and vapor/liquid extraction operations to reduce the VOC loading on the treatment system.	Routine operational monitoring of the treatment system influent and effluent vapor and groundwater VOC concentrations.
		Operational period may be longer than the 180 to 240 days estimated.	Respond in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).	Monitor in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).

Table 3. Uncertainty Matrix for Phase IIa of the C-400 IRA (Continued)

Expected Condition	Potential Deviation	Impact of Deviation	Contingency	Monitoring
Underground hazards and obstructions have been identified.	Additional underground obstacles encountered during installation of subsurface ERH components.	May require changes to proposed locations of subsurface components such as electrodes, extraction wells, temperature and pressure monitoring sensors. According to the RDR (DOE 2012), electrodes can be relocated up to 3 ft in any direction without affecting expected heating conditions. Other subsurface components can be moved as necessary.	Field changes to subsurface component locations will be made in consultation with subject matter experts from the ERH vendor to ensure that heating, extraction, and monitoring functions are not negatively impacted.	N/A
Required temperatures are achieved in the subsurface during the estimated operations period.	Subsurface temperatures do not reach design levels within the expected operations period due to unforeseen subsurface conditions.	VOCs may not be adequately volatilized in the affected zones.	Direct additional energy to electrodes in the affected zones and respond in accordance with the criteria for ceasing operations documented in the RDR (DOE 2012).	Monitor in accordance with the criteria for ceasing operations.
	Subsurface temperatures do not reach design levels within the expected operations period due to electrode failure.	Uniform heating not achieved and VOCs not adequately volatilized.	Corrective maintenance to attempt to restore operations of failed electrodes, increase power to adjacent electrodes to compensate for failed electrodes.	Routine monitoring of subsurface temperatures and power consumption at electrodes.
Vapor recovery wells provide adequate area of influence for subsurface vapor recovery.	Vapor recovery well area of influence is not adequate.	Volatilized VOCs not adequately recovered from the subsurface.	Connect piezometers and contingency wells to the vapor recovery process to enhance recovery network array.	Routine monitoring of subsurface pressure via a network of piezometers.

Table 3. Uncertainty Matrix for Phase IIa of the C-400 IRA (Continued)

Expected Condition	Potential Deviation	Impact of Deviation	Contingency	Monitoring
Minimal to no migration of volatilized VOCs out of the treatment zone.	Hydraulic control in the upper RGA and pneumatic control in the UCRS is not maintained within the treatment area.	Increase in TCE concentrations in the dissolved phase plume in the RGA beyond the boundaries of the treatment zone or VOCs re-condensing outside of treatment zone in the UCRS.	Extraction wells with submersible groundwater pumps will be installed for initiating and maintaining hydraulic control within the upper RGA. Groundwater extraction from the upper RGA and injection rates will be monitored to ensure more water is extracted than is put back into the formation. Operators will make adjustments to rates of vapor extraction in the UCRS and groundwater extraction in the upper RGA as needed. Additional contingency actions will be taken in the event of a power loss. An emergency backup generator will be available to operate critical treatment system equipment to maintain pneumatic control in the event of a power failure.	Water withdrawal and addition rates will be monitored as will vapor pressure at vacuum monitoring piezometers as well as extraction wells across the treatment area.
When the ROD criteria of heating in the subsurface and asymptosis in the off gas are met, the incremental TCE removal rate will be low, but the cumulative TCE removal volume will be at the maximum.	When the ROD criteria are met, the mass removal rate is still significant compared to the cumulative mass volume removed/estimated.	If all parts of the system, heating and vapor extraction, are shut down, the potential for additional cost-effective gains in the contaminant removal objective may be missed.	The FFA parties will consult with one another to reach consensus as to whether the system should remain in operation after the remediation goal has been met and, if so, under what conditions.	N/A

Table 3. Uncertainty Matrix for Phase IIa of the C-400 IRA (Continued)

Expected Condition	Potential Deviation	Impact of Deviation	Contingency	Monitoring
Uninterrupted electrical power supply.	Power outages due to supply system problems.	Vaporized VOCs and steam could recondense if not extracted due to extended vapor extraction or treatment system shutdown.	Back up electrical power will be provided via an emergency power generator, which would supply electricity for critical service equipment.	N/A
Reliable service expected from all critical treatment system equipment.	Extended system shut down due to equipment failure.	Vaporized VOCs and steam could recondense if not extracted due to extended vapor extraction or treatment system shutdown.	Identify critical service equipment requiring long lead time for replacement. Adequate spare parts inventory will be established and maintained.	N/A

N/A = not applicable

4. REMEDIAL ACTION APPROACH

The DOE Environmental Restoration (ER) contractor has overall contractor responsibility for the design, construction, sampling and analysis, operations and maintenance (O&M), waste management, and disposal associated with the remedy. The major activities for this remedial action are outlined in this section.

Table 4 is a general list of activities typically governed by procedures. Procedures referenced in the table are those followed by the current DOE prime contractor. If a change in DOE prime contractor occurs, the procedures followed by the new DOE prime contractor will be substantially equivalent to those referenced below. The most current versions of all contractor procedures are to be used. The quality assurance project plan (QAPP), RAWP, RDR, construction quality control plan (CQCP), and all applicable procedures will be readily available in the field to all project personnel, including subcontractors, either in hard copy or electronic format.

Table 4. General Activities Governed by Procedures

Activity	Applicable Procedure
Accident/Incident Reporting	PAD-SH-1007, *Incident/Event Reporting*
Analytical Laboratory Interface	PAD-ENM-5004, *Sample Tracking, Lab Coordination, & Sample Handling Guidance*
Calibration of Measuring and Test Equipment	PAD-QA-1020, *Control and Calibration of Measuring and Test Equipment*
Chain-of-Custody	PAD-ENM-2708, *Chain-of-Custody forms, Field Sample Logs, Sample Labels, and Custody Seals*
Collection of Samples	PAD-ENM-0018, *Sampling Containerized Waste* PAD-ENM-0023, *Composite Sampling* PAD-ENM-2101, *Groundwater Sampling* PAD-ENM-2300, *Collection of Soil Samples* PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation* PAD-IH-5560, *Workplace Industrial Hygiene Sampling*
Conducting Assessments	PAD-QA-1420, *Conduct of Management Assessments* PAD-REG-0003, *Performing Environmental Compliance Assessments and Identification and Reporting of Environmental Issues*
Construction Equipment Inspection	PAD-SM-0006, *Construction Equipment Inspection and Maintenance*
Control of Sample Temperature	PAD-ENM-0021, *Temperature Control for Sample Storage*
Data Verification and Validation	PAD-ENM-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* PAD-ENM-0811, *Pesticide and PCB Data Verification and Validation* PAD-ENM-5102, *Radiochemical Data Verification and Validation* PAD-ENM-5103, *Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Data Verification and Validation* PAD-ENM-5105, *Volatile and Semivolatile Data Verification and Validation* PAD-ENM-5107, *Inorganic Data Verification and Validation*
Decontamination of Large Equipment	PAD-DD-2701, *Large Equipment Decontamination*
Decontamination of Sampling Equipment	PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*
Document Control	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents*

Table 4. General Activities Governed by Procedures (Continued)

Activity	Applicable Procedure
Documenting and Controlling Field Changes to Approved Plans	PAD-WC-0021, *Work Release and Field Execution* PAD-ENG-0027, *Field Change Request (FCR), Field Change Notice (FCN), and Design Change Notice (DCN) Process*
Evaluations for Suspect/Counterfeit Items	PAD-QA-1009, *Identification, Control, and Disposition of Suspect/Counterfeit Items*
Fall Prevention	PAD-SH-2004, *Fall Prevention and Protection*
Field Engineering Inspections and Surveys	PAD-ENG-0001, *Field Engineering Inspections and Surveys*
Field Logbooks	PAD-ENM-2700, *Logbooks and Data Forms*
Graded Approach	PAD-QA-1650, *Graded Approach*
Handling, Transporting, and Relocating Waste Containers	PAD-WD-0661, *Transportation Safety Document for On-Site Transport within the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Hoisting and Rigging Operations	PAD-ENG-0012, *Hoisting and Rigging Operations*
Inspection and Test Plans and Review of Vendor/Supplier QA Program	PAD-QA-1208, Approved *Supplier Selection and Evaluation*
Issue Management (includes corrective action)	PAD-QA-1210, *Issues Management*
Lithologic Logging	PAD-ENM-2303, *Borehole Logging*
Nonconforming Items and Services	PAD-QA-1440, *Control of Nonconforming Items, Services, Procedures, and Processes* PAD-SH-2001, *Identifying Defective Equipment*
Powered Industrial Trucks	PAD-SH-2007, *Powered Industrial Trucks*
Quality Assured Data	PAD-ENM-5003, *Quality Assured Data*
Quality Assurance Program	PAD-PLA-QM-001, *Quality Assurance Program and Implementation Plan for the Paducah Environmental Remediation Project, Paducah Kentucky*
Radiation Protection	PAD-PLA-HS-002, *Radiation Protection Program for the Paducah Remediation Services Project*
Records Management	PAD-RM-1009, *Records Management, Administrative Record, and Document Control*
Revisions to Procedures or Work Packages	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents* PAD-WC-0018, *Work Planning and Control Program for the Paducah Environmental Remediation Project Paducah, Kentucky* PAD-WC-0021, *Work Release and Field Execution*
Shared Site Issue Resolution	PAD-WC-4010, *Shared Site Issues*
Shipping Samples	PAD-WD-9503, *Off-Site Shipments by Air Transport*
Subcontract Management	PAD-CP-0008, *Receipt and Evaluation of Proposals*
Suspend/Stop Work	PAD-SH-2018, *Stop/Suspend Work (Safety Related)*
Temperature Extremes	PAD-IH-5134, *Temperature Extremes*
Training	PAD-TR-0702, *Conduct of Training* PAD-TR-0710, *Assignment of Training* PAD-TR-0750, *Required Reading*
Transmission of Data	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*
Vendor/supplier evaluations	PAD-QA-1208, *Approved Supplier Selection and Evaluation*
Waste Management and Disposition	PAD-WD-0016, *Waste Handling and Storage in DOE Waste Storage Facilities* PAD-WD-0437, *Waste Characterization and Profiling* PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Storage of Regulated Waste Materials at Paducah*

4.1 DESIGN

As discussed previously, Phase IIa of the C-400 IRA will result in the implementation of ERH in the UCRS and upper RGA soils in the southeast treatment area. The treatment depth interval targeted for heating and TCE removal is from 20 ft bgs to 60 ft bgs. Based on Phase I observations, the actual heated depth interval may be from approximately 18 ft bgs to 63 ft bgs. The design phase of the project will address lessons learned during Phase I to improve performance of the vapor extraction system. Design activities also will focus on modifications to improve operational monitoring and reporting processes and replacement of the vapor treatment technology to something that is less complicated and costly to operate. The design is documented in the RDR (DOE 2012).

4.2 CONSTRUCTION

The construction phase of the Phase IIa ERH system will include site preparation and installation of subsurface electrodes, extraction wells, subsurface temperature monitoring equipment, vacuum monitoring piezometer, and an aboveground vapor and liquid treatment system.

Site preparation will include removal of interfering C-400 infrastructure. In the southeast treatment area, a concrete loading dock wall will be removed to allow for drilling and installation of ERH components. A vapor cap constructed of high density polyethylene is being considered for grassy and gravelly areas in the southeast treatment area.

Many components of the ERH system will be installed in subsurface borings. These borings will be completed under the direction of a certified driller. Sonic drilling is the preferred method of installation for the ERH electrodes; however, in some locations, sonic drilling equipment may not fit within the congested work area and an alternate drilling method will be used. Additionally, auger drilling may be used for installation of other ERH components.

Electrode well borings will be approximately 12-inch diameter borings. After the boring is completed, the electrode will be lowered into the boring with an organic solvent and heat resistant synthetic support rope. When adding sand to an electrode well, sand will be added to the inside of the sonic drill stem maintaining 2 ft of fill material inside the drill stem at all times. Sonic casing will be vibrated as it is being removed allowing the sand to be packed around the electrode and into the annulus. Where required, a well screen will be installed and sanded in place. The boring then will be completed with well materials (bentonite, grout, etc.) per the design.

Extraction well borings will be approximately 8-inch borings; DigiTAM sensor borings and vacuum monitoring or combination vacuum monitoring/DigiTAM sensor borings will be approximately 7-inch borings; contingency well borings will be 6-inch borings; and DigiTAM sensor well borings will be 6-inch borings. Where required, well screen will be installed and sanded in place. The boring then will be completed with well materials (bentonite, grout, etc.) per the design.

The extraction piping and wellheads will be installed with the completion of the subsurface equipment. After the power delivery system and water circulation systems are in place, the leads and hoses will be run from the wellheads to their preassigned location at each piece of equipment.

4.3 SAMPLING AND ANALYSIS

Three distinct phases of sampling and analysis will occur as a part of the C-400 Phase IIa IRA: baseline, operational, and postoperational. Baseline sampling and postoperational sampling will be conducted as a means to determine the percent reduction in VOC contamination in the treatment area. The sampling plan for baseline and postoperational sampling activities are presented in Section 8.1 of this RAWP.

Operational sampling and analysis will be used to measure progress and determine when criteria for ceasing operations have been met. Additional discussion of operational sampling can be found in Section 8.2. A sampling and analysis plan for operational sampling will be included in the O&M Plan to be revised and submitted for review in accordance with the planning schedule in Section 6 of this RAWP. Section 8.3 addresses waste characterization sampling and analysis.

4.4 OPERATION AND MAINTENANCE

A period of system startup and preoperational testing will be conducted prior to normal operations. During this startup period, vapor and liquid extraction will be initiated before the electrodes are energized. Initial start-up of the system involves first starting the multiphase extraction system to establish hydraulic control. Secondly, the vapor recovery system will be started once hydraulic balance is achieved or if routine monitoring at the surface and in the vicinity of site workers indicates that VOC vapors are migrating to the surface. Any detectible levels of organic vapors will be investigated to determine the source. The shallow XE wells will be activated, as necessary, to ensure that vapor capture is complete. Lastly, start-up of the ERH system involves activating the various components (i.e., power delivery systems, water circulation components, energizing electrodes, etc.) and ensuring the components operate within the design parameters. Additional detail regarding system startup can be found in the O&M plan.

The system is expected to operate 24 hours per day, 7 days per week. Operators will be on-site during normal business hours during routine operations. The ERH vendor will remain part of the operations team and is providing an operator. The subsurface equipment also will be monitored and adjusted remotely by the ERH vendor. System operational measurements and preventative maintenance will occur on a regular basis to ensure the system is functioning properly. Operational checks will include measuring critical system parameters such as soil temperature and VOC recovery. Maintenance activities will include lubrication and minor adjustment of system components. The maintenance activities will be conducted as required by the equipment manufacturers and sound engineering practices. Adjustments to system components will be directed by the appropriate subject matter experts. An O&M Plan has been developed to address system start-up, normal operations, lessons learned, routine maintenance, and system shutdown activities for the ERH components, as well as the aboveground vapor and liquids treatment components. The O&M Plan will be revised to reflect changes identified during Phase I and submitted for review in accordance with the planning schedule in Section 6 of this RAWP.

4.5 OPERATIONAL MONITORING

To review remediation progress, a project Web site will be developed for management and review of pertinent thermal, energy, and process data. The information gathered from the digiTAMs, power delivery systems, and meter and gage readings (i.e., vacuum pressures at piezometers, temperature measurements, and flow rates at multiphase wells) recorded by on-site personnel will be posted on the Web site.

Data collected digitally by the server will be stored in a database, uploaded regularly to the ERH subcontractor's Web server, and presented on the project Web site. Manually collected readings will be recorded and updated on the Web site weekly. The password-protected Web site will provide the user with real-time and historical data collected during the operations phase of the project.

4.6 WASTE MANAGEMENT AND DISPOSITION

Waste generated during installation, operations, and decommissioning of the C-400 IRA will be managed and dispositioned in accordance with the Waste Management Plan (WMP) and applicable or relevant and appropriate requirements (ARAR). Waste characterization will be performed using analytical results from waste sample analysis discussed in Section 8.3 and from process knowledge where applicable. Refer to the WMP in Section 12 for additional detail concerning waste management and disposition.

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5. PROJECT ORGANIZATION

The project organization chart showing relationships of key personnel and organizations is shown in Figure 5. Plan-of-the-day/pre-job briefings will provide personnel an opportunity to discuss daily activities and any issues. Field changes will be made and documented in accordance with Section 9.17. All personnel have "stop work authority" and the responsibility to use this authority in accordance with PAD-SH-2018, *Suspension of Work (Safety Related),* when they perceive the safety of workers or the public to be at risk.

- DOE—Lead agency. DOE performs oversight of LATA Environmental Services of Kentucky, LLC (LATA Kentucky) and the project. DOE reviews and approves project documents and participates, as needed, in Readiness Reviews. DOE also is responsible for communications with the U.S. Environmental Protection Agency (EPA) and state regulatory agencies.

- Contractor—Responsible for communications with DOE and for planning, overseeing, and completing the project.

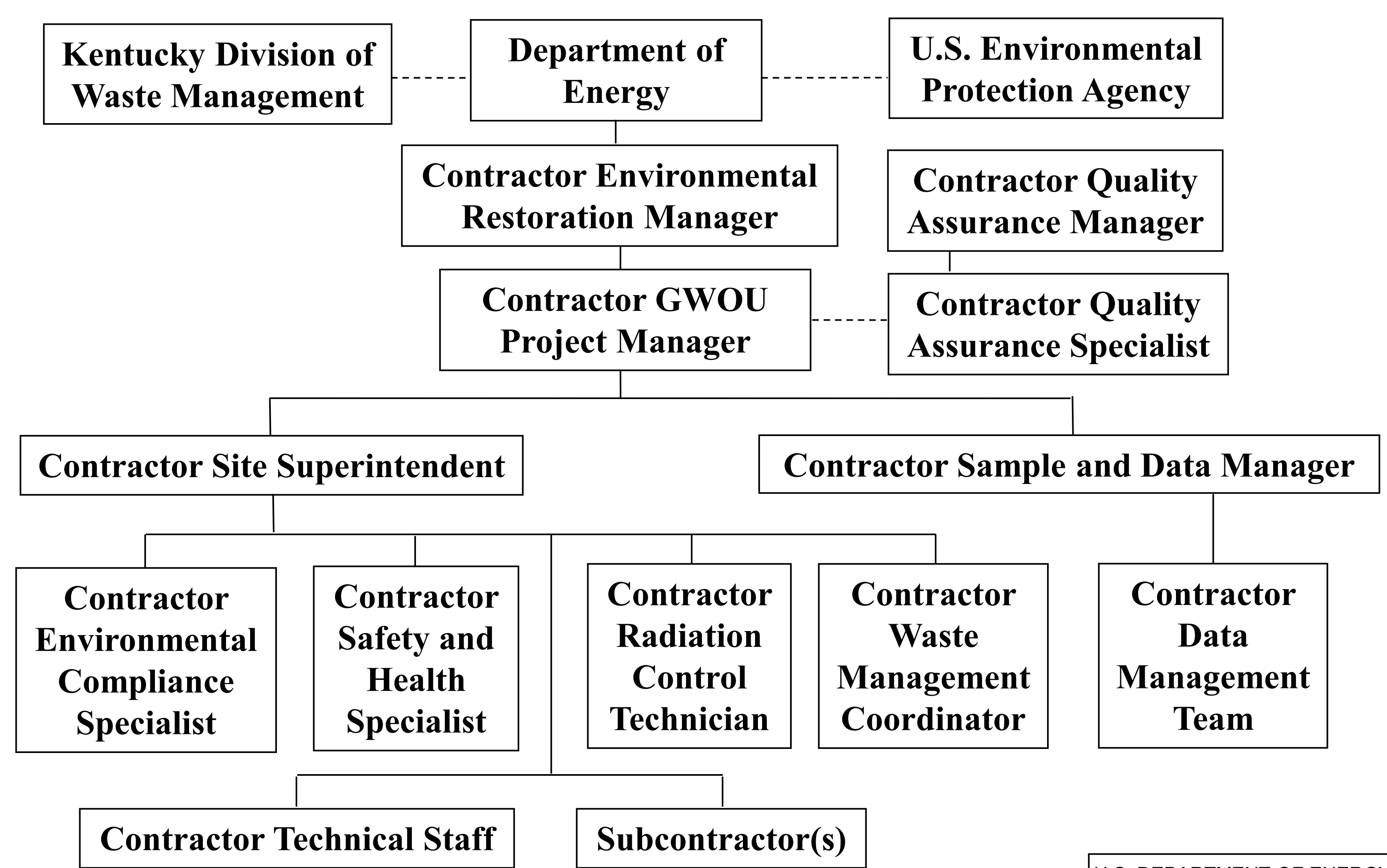
- Contractor Manager of Projects—Serves as the primary point of contact with DOE to implement site-wide environmental restoration programs. Performs work in accordance with the baseline scope and schedule and directs the day-to-day activities of DOE contractor personnel performing environmental monitoring and restoration activities.

- Contractor Groundwater Operable Unit (GWOU) Project Manager—Serves as the IRA primary point of contact and is responsible for the performance, quality, schedule, and budget. Provides overall project direction and execution, implements corrective actions as necessary, verifies compliance with safety and health requirements, and participates in the readiness review. Leads the effort to define the scope of an environmental problem or facility operation. Directs the project team in determining potential sources of existing data, identifying the study area and/or facility to be addressed by the project, and selecting the most effective data collection approach to pursue. May also be the technical contact for subcontracted project support and should ensure that the flow down of data management requirements are defined in a statement of work (SOW).

- Contractor Quality Assurance (QA) Manager—Responsible for coordination with the project QA staff to ensure an appropriate level of QA oversight. Schedules audits and surveillances needed to verify compliance with quality commitments and requirements. Has overall responsibility of approving, tracking, and evaluating effectiveness of corrective actions. Receives copies of field changes and approves field changes related to quality. The QA manager is independent of the project.

- Contractor QA Specialist—Performs oversight to verify work is completed in accordance with the QAPP and/or the Data Management and Implementation Plan (DMIP). Responsible for reviewing project documentation to determine if the project team followed applicable procedures.

- Contractor Site Superintendent—Oversees all field activities and verifies that field operations follow established and approved plans and procedures. 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 IRA project manager during field activities.



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

Figure 5. Project Organization

LATA Environmental Services of Kentucky, LLC

- Contractor Safety and Health Specialist—Develops the health and safety plan (HASP) and oversees implementation of Integrated Safety Management System (ISMS) and the overall safety and health of employees, both in the field and the office. Provides direct support to the GWOU project manager concerning the safety and health of project personnel and the general public and impacts to property and the environment. Ensures that each task has the proper safety and health controls in place before work begins, meeting all federal, state, and local regulations.

- Contractor Environmental Compliance Specialist—Ensure project activities are conducted in compliance with environmental laws and regulations including, but not limited to, National Environmental Policy Act and Clean Air Act, permits, regulatory agreements and documents, DOE Orders and Directives, and company policies and procedures. Review and prepare technical and regulatory documents/reports, National Emission Standards for Hazardous Air Pollutants (NESHAP) Reports, solid waste management unit (SWMU) Notifications and Assessment Reports, and permit applications/modifications. Conduct regulatory research and reporting, perform field inspections, and support waste minimization and pollution prevention activities. Support implementation of the ISMS and Environmental Management System.

- Contractor Radiation Control Technician—Implement the day-to-day programmatic aspects of the Radiation Protection Program. Perform air sampling, radiation surveys, radioactive contamination control and monitoring, access control, posting and labeling, completion and management of records, responding to accidents and emergencies, vehicle and equipment control, instrumentation source check, personnel decontamination, and minor equipment decontamination during the course of surveying. Generate radiological data records and reports.

- Contractor Technical Staff—Provides direct support to the site superintendent and GWOU project manager concerning technical aspects of the project during remedial design, construction, and operation.

- Contractor Waste Management Coordinator—Ensures adherence to the WMP, documents and tracks field-related activities, including waste generation and handling, waste characterization sampling, waste transfer, and waste labeling. The waste management coordinator (WMC) will perform the majority of waste handling field activities.

- Contractor Sample and Data Management Manager—Responsible for the coordination of all sampling activities. Ensures that all quality control sampling requirements are met, chain-of-custody forms are generated properly. Responsible for managing data generated during the remedial design, construction, and operation in accordance with the DMIP.

- Contractor Data Management Team—Responsible for entering project information into the project records file and/or database and ensuring that all information has been entered correctly. Ensures that hard copy data records are processed according to data records management requirements. Works with field teams to facilitate data collection and verification and with data users to ensure easy access to the data. Performs data reviews, verification and assessment, as appropriate. Determines project data usability by comparing the data against predefined acceptance criteria and assessing that the data are sufficient for intended use. Ensures that analytical methods, detection limits, minimum detectable activities, laboratory quality control (QC) requirements, and deliverable requirements are specified in the SOW and that the SOW incorporates necessary deliverables so that data packages from the laboratory will be appropriate for verification and validation. Responsible for contracting any fixed-base laboratory utilized during sampling activities. Incorporates any existing data or new project data into the project's hard-copy data record file or data base, as appropriate. Performs data reviews, verification and assessment, 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 (OREIS).

- Subcontractor(s)—An ERH specialty subcontractor will be hired to provide equipment and expertise during the design, construction, and operation of the ERH system. A drilling subcontractor will be hired to install all subsurface borings and assist the ERH subcontractor with installation of ERH system components.

6. PROJECT PLANNING SCHEDULE

A generalized project planning schedule is shown in Table 5.[3]

Table 5. Project Planning Schedule

Activity	Date
Completion of the RDSI	Completed August 2006
Complete Phase I Installation	Completed November 2009
Begin Phase I Routine Operations	Completed March 2010
Complete Phase I Operations	Completed October 2010
Implementation of Phase II Field Sampling Plan	Completed July 2011
Approval of Phase IIa RDR	July 2012
Approval of Phase IIa RAWP	August 2012
Begin Installation of Phase IIa ERH Components	September 2012
Complete Infrastructure Removal (loading dock wall)	October 2012
Complete Phase IIa Installation	~ 9 months after start up of Phase IIa installation
Issue Draft Phase IIa O&M Plan to EPA/KDEP	November 2012
Approval of Phase IIa O&M Plan (revised from Phase I)	February 2013
Begin Phase IIa Start Up and Testing	Following completion of Phase IIa installation
Begin Phase IIa ERH Operations	Following completion of Phase IIa start up and testing
Complete Phase IIa ERH Operations	~ 8 months after beginning Phase IIa ERH operations
Remedial Action Completion Report (includes the Postconstruction Report)	Following completion of the remedial action

Note: The construction quality control plan from Phase I operations is applicable to Phase IIa operations and will not require a revision.

[3] Projected 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 remedial action or this document. The enforceable milestones for performance of activities included as part of the remedial action are set forth in the Federal Facility Agreement (FFA) (EPA 1998). Any additional milestones, timetables, or deadlines for activities included as part of the remedial action will be identified and established independent of this RAWP, in accordance with existing FFA protocols.

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7. HEALTH AND SAFETY PLAN

This HASP has been developed to discuss the general standards and practices to be used during execution of the C-400 IRA to protect the safety and health of workers and the public. Site-specific hazards and controls will be established for each task and location prior to performing work. These hazards and controls will be documented in the form of a site-specific HASP, activity hazard assessments (AHAs), work control documents, and procedures. Personnel will be familiar with these work control documents prior to performing work in the affected areas. This work will be performed in accordance with the DOE's ISMS and its environmental compliance and health and safety requirements; these establish a goal of zero-accident performance. Hazard controls will include access restrictions, operator-training requirements, exclusion of nonessential personnel from the work zone, use of personal protective equipment (PPE), and other relevant controls.

7.1 INTEGRATED SAFETY MANAGEMENT SYSTEM

The project team is committed to implementing ISMS that integrates 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 will be utilized to provide a formal, organized process to ensure the safe performance of work. The ISMS Plan identifies the methodologies that will be used to address previously recognized hazards and how the hazards are mitigated using accepted health and safety practices.

This project will pursue the DOE's goal of zero-accident performance through project-specific implementation of ISMS. The core functions and guiding principles of ISMS will be implemented by complying with 10 *CFR* § 851, *Worker Safety and Health Program* and incorporating applicable DOE orders, policies, technical specifications, and guidance. A brief description of the five ISMS core functions is provided below.

7.1.1 Define Scope of Work

Defining and understanding the scope of work is the first critical step 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 may conduct a project team-planning meeting to discuss the team's general understanding of the scope and the technical and safety issues involved. This meeting is conducted to ensure all parities are in agreement on the scope and general approach to complete the scope.

7.1.2 Analyze Hazards

In the course of planning the work, the project team will identify hazards 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.

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 work controls, which serve to provide a control mechanism for all work activities. Work control documents are tailored to the work to be performed and include the hazard assessment process, which entails a detailed evaluation of each task to identify specific activities or operations that will be required to successfully complete the scope of work and defines 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 PPE. This approach has been developed to be consistent with the requirements in Occupational Safety and Health Administration (OSHA) regulations for Health and Safety Plans for Hazardous Waste Operations and Emergency Response (29 *CFR* § 1910.120 and § 1926.65). The project team is responsible for the preparation, revision, and implementation of all work controls.

The site superintendent (or designee) will review all work controls AHAs with the personnel who will perform the work. Participants in this review will sign and date the AHA to signify they understand all hazards, preventative measures, and requirements. A copy of the work control documents with appropriate signatures shall be maintained at the work location.

7.1.3 Develop and Implement Hazards Controls

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

- Prework briefings
- Task work instructions
- Training
- Plan-of-the-day/preshift briefings
- AHAs
- Radiological work permits (RWPs)

A project-specific prework briefing will be completed after the work controls have been developed, reviewed, revised, and approved. The meeting will include a thorough review of the scope of work to be performed, the contents of the work controls, and any project-specific information necessary to supplement the HASP. All personnel who will be conducting site activities, including subcontractors, will be briefed on the required information. As part of that briefing, employee involvement will be emphasized and encouraged in all phases of the planned work.

The prework briefing also incorporates the principles of ISMS. The specific steps within ISMS are emphasized to each employee. It is emphasized that no employees will be directed or forced to perform any task that they believe is unsafe, puts their health at risk, or that could endanger the public or the environment. One of the key elements of ISMS is that all personnel have “stop work authority” and the responsibility to use this authority when they perceive the safety of workers or the public to be at risk.

Employee involvement is emphasized in aspects of the project, beginning with prework briefing and periodically being reinforced in daily preshift briefings/meetings. Whenever possible, employees are involved in the selection, development, and presentation of safety topics and their full and constructive input is encouraged in all communication sessions.

7.1.4 Perform Work within Controls

Once the project team has been given notice to proceed, the project-specific plans will be implemented. The project team will verify that all applicable plans, forms, and records are contained in the field project files to be kept on-site and accessible by all parties. Actions that will be taken during the performance of the work to incorporate these ISMS principles:

- Plan-of-the-day/preshift briefings
- Safety and health oversight/inspections
- Daily inspection of equipment
- Stop work authority

During field work, daily preshift briefings (e.g., safety tailgate or toolbox meetings) will be conducted with all personnel participating, including subcontractor personnel. These sessions also will focus on fostering two-way communication, eliciting feedback, and reinforcing employee involvement.

Although line management holds the ultimate responsibility and accountability for safety and health matters, this does not, in any way, absolve individual employees from fulfilling their personal safety and health responsibilities. Each project employee is responsible for his/her own health and safety, including performing his/her work in accordance with established requirements, complying with specified policies and procedures, performing his/her work in a manner that is consistent with training and communications received, and actively participating in the safety and health program to continuously improve its effectiveness. The opportunity for employees to provide periodic feedback is provided during the daily briefing.

7.1.5 Feedback/Improvement

Feedback and improvement are accomplished through several channels, including safety audits, self-assessments, employee suggestions, lessons learned, and pre-job briefings. These actions will be used to solicit worker feedback, as well as to identify, address, and communicate lessons learned using standard corrective action planning and continuous improvement processes.

A cornerstone of any effective safety and health program is the active involvement and participation of employees that it is designed to protect. An essential element of this is thorough communication and feedback throughout the organization, with an emphasis on identifying opportunities for continuous improvement of the program. The objective of active employee involvement in the worker safety and health program is to develop a culture in which employees feel empowered and take ownership of the program.

GWOU line management will encourage employees to submit suggestions that offer opportunities for improvement.

At the conclusion of fieldwork, a post-job briefing will be conducted to allow project personnel to communicate:

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

7.2 KEY CONTRACTOR SAFETY AND HEALTH RESPONSIBILITIES

7.2.1 GWOU Project Manager

The GWOU project manager has overall responsibility and authority to direct technical, management, cost, and contractual matters related to the project. The GWOU project manager ultimately is responsible for the safety and health of employees performing project-associated activities on the site.

Specific responsibilities of the GWOU project manager will include, but are not be limited to, the following:

- Ensures that project work is conducted safely;
- Serves as primary point of contact for the project;
- Identifies required safety and health needs, provides adequate resources, and ensures that project personnel are trained in requirements;
- Implements and enforces applicable plans, procedures, and other work control requirements;
- Consults on safety-related matters with the site superintendent, the safety and training manager, and the safety and health specialist; and
- Participates with the site superintendent, the safety and training manager, and the safety and health specialist in investigations or disciplinary actions for environmental, safety and health violations.

7.2.2 Site Superintendent

The site superintendent will oversee the field activities associated with the project and will be responsible for overall execution of the field activities associated with the project. He or she is responsible for enforcing the requirements of this plan. Specific responsibilities of the site superintendent are listed below.

- Enforces compliance with the project plans, procedures and work control requirements.
- Coordinates on-site operations, including subcontractor activities.
- Ensures that all filed work is conducted safely and in accordance with the requirements of the applicable work control.
- Ensure that all on-site personnel have the required training and certifications.
- Coordinates and controls any emergency response actions.
- Reports accidents and injuries through the appropriate channels; and conducts accident/incident investigations as required, including the completion of appropriate forms.
- Conducts or ensures work site inspections.
- Conducts or ensures daily preshift briefings.

- Maintains current copies of the project work controls on-site.

7.2.3 Safety and Health Specialist

The safety and health specialist has the following responsibilities and authorities:

- During fieldwork, conducts daily health and safety inspections of contractor/subcontractor work activities.
- Stops work and consults with project personnel to ensure the safety or health of those personnel, other site personnel, or third parties.
- Establishes and ensures adherence to the Worker Safety and Health Program, work control, and applicable safety and health procedures.
- Establishes and maintains systems to inform personnel on how to respond to emergency warning systems for the project (including evacuation alarms, accountability rosters, assembly points, etc.).
- During fieldwork activities, participates in preshift briefings.
- Ensures that the first aid kits and other emergency equipment are kept current.
- Ensures that proper chemical and safety postings are in place and legible.
- Ensures that all operations are conducted so as to mitigate adverse environmental impacts (e.g., spill containment, erosion control).
- Implements personnel Industrial Hygiene monitoring strategies to include, but not limit to, personal air monitoring (breathing zone), ambient breathing zone monitoring, noise surveys, and heat stress monitoring.
- Performs personnel monitoring to evaluate existing and potential exposure to chemical, physical, and biological hazards.
- Interprets, reports, and takes appropriate actions indicated by personnel monitoring results.
- Evaluates the site for any hazards not identified in the AHA, initiates safety measures required to protect personnel, and revises documents accordingly.
- Establishes and maintains programs required to mitigate hazards identified in the AHA.
- Maintains first aid and OSHA 300 logs; reports accidents and injuries through the appropriate channels; and assists with accident/incident investigations as required, including the completion of appropriate forms.
- Coordinates with off-site emergency responders and medical service organizations to establish required services and verify that phone numbers, addresses, and contacts are current and accurate.

7.2.4 Safety and Training Manager

The safety and training manager has the following responsibilities:

- Reviews and approves all site-specific HASPs.
- Oversees implementation of the Worker Safety and Health Program and implementation of safety and health procedures.
- Conducts, or approves personnel to conduct, safety and health surveillances and audits and directs and mentors the safety and health specialist.
- Investigate accidents, incidents, injuries, and illnesses and analyze for trends and lessons learned coordinate with project managers, supervisors, and subcontract coordinators on accident investigations.
- Ensures industrial hygiene sampling is conducted and resulting data are reviewed accordingly.
- Ensures hazard analyses are conducted consistent with the ISMS process to anticipate and control physical and chemical hazards.

7.3 REPORT/RECORDKEEPING

Project requirements include the following:

- All accidents and near misses must be reported to the safety and health specialist and the site superintendent immediately.
- Proof of personnel training and medical clearances required for this project will be maintained.

7.4 MEDICAL SURVEILLANCE

The medical surveillance program provides for baseline, annual, and termination medical examinations for the project team in accordance with 29 *CFR* § 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER).

Employees and subcontractors conducting HAZWOPER fieldwork must complete an annual HAZWOPER physical. The examining physician will document the worker's fitness for work and ability to wear a respirator.

Radiation workers, working under a RWP, may be required to submit a site specific baseline bioassay and periodic bioassay as need through the project. Detailed explanation of the radiation worker requirements is described in PAD-PLA-HS-002, *Radiation Protection Program for the Paducah Remediation Services Project*.

7.5 FIRST AID AND MEDICAL SERVICES

Project requirements include all of the following:

- Nonemergency medical care will be provided by personnel with current first aid or first responder training and/or designated occupational medical provider as needed.

- The PGDP emergency response organization will be the primary resource for time-urgent emergency medical care during this project.

- All job-related injuries or illnesses must be reported immediately to the safety and health specialist and the site superintendent.

7.6 TRAINING

7.6.1 Hazardous Waste Worker Training

Site personnel, such as equipment operators and field technicians, will be required to have successfully completed the initial 40-hour HAZWOPER training, including all required annual updates consisting of eight hours of refresher training, as well as, three days of on-the-job training under the direct supervision of a trained, experienced supervisor. Personnel occasionally on-site for a specific limited task who are unlikely to be exposed above the permissible exposure limit will be required to have successfully completed a minimum of 24 hours of initial training. Site visitors (observers) will be restricted to the Support Zone unless documentation of training is presented.

7.6.2 Subcontractor Training

All subcontractor employees must provide documentation for training that is pertinent and relevant for the tasks to be performed and necessary for compliance with local, state, or federal regulations. Additional training may be required as needed.

7.6.3 Site Specific Training

All personnel may be required to attend the following site-specific training:

- General Employee Training (GET), and
- Radiological Worker II Training.

Additional training may be required as needed. This training may include (but not be limited to) the following:

- Fire extinguisher,
- Lockout/tagout, and
- Respiratory protection.

7.7 ACTIVITY HAZARD ASSESSMENT

An AHA will be prepared for the major tasks planned for this project with the assistance of workers familiar with the type of tasks to be performed. If additional tasks are identified, the hazards and necessary controls will be determined and documented in an additional or revised AHA. The initial or revised AHA must be approved and reviewed with personnel prior to initiating these tasks.

All workers will be briefed on the AHA as it applies to their work. This briefing will be documented by signing the AHA. Following completion of an activity, employees are encouraged to provide feedback, and “lessons learned” will be documented.

The safe and effective implementation of the electrical heating technology necessitates that proper health and safety precautions be taken. These precautions will be included in project specific work control documents. The electrical heating technology uses voltage that is less than 600 volts. The ERH system vendor uses an electrical grounding system that is installed during the construction of the treatment system to ensure that voltage potentials at the surface do not exceed National Electric Code guidelines of 15 volts. The electrical equipment used to transmit electrical energy to the subsurface has been designed to meet applicable electric codes and provide fail-safe operation. Work control documents will be implemented to address working with materials and fluids that will have the potential to be at high temperatures. High subsurface pressures are not expected during operation of the treatment system.

7.8 FACILITY/SITE ACCESS CONTROL

Work zones will be utilized to control access. These areas will be controlled by the appropriate subcontractor to minimize the number of individuals potentially exposed to site hazards and to ensure that individuals who enter follow the required procedures. The following is a description of the different types of zones that may be established at the site.

- Exclusion Zone (EZ)—The area where work is being performed and chemical, physical, and/or radiological hazards exist. Entry into this area is controlled and the area clearly marked with barrier tape, rope, or flagging. Signage required by OSHA will be posted. Unauthorized entry into these areas is strictly prohibited. Permission to enter the EZ is granted by the safety and health specialist or designee.

- Contamination Reduction Zone (CRZ)—The transition area between the EZ and support area. This area will provide a buffer area to reduce the probability that contamination will leave the EZ and reduce the possibility of the support area becoming contaminated by site hazards. The degree of contamination in the CRZ decreases as the distance from the contaminants increases.

- Support Area—The outermost area of the work site. This area is uncontaminated where workers provide operational and administrative support. The support area is clean and will not be entered by contaminated equipment or personnel, except under emergency or evacuation conditions. Normal work clothes are appropriate within this area.

- Construction Zone—The area outside of potential contamination, but encompassing work activities and possible hazards associated with construction activities. Entry into this area is controlled and the area clearly marked with barrier tape, rope, flagging and/or signage. Applicable signage will be posted to adequately communicate hazards and entry requirements.

7.9 HAZARD COMMUNICATION

OSHA's 29 *CFR* § 1910.1200, "Hazard Communication Standard," states that all employees handling or using hazardous or potentially hazardous materials be advised and informed of the health hazards associated with those materials.

7.9.1 Material Safety Data Sheet

A material safety data sheet (MSDS) provides specific material identification information; ingredients and hazards; physical data; fire and explosion information; reactivity data; health hazard information; spill, risk, and disposal procedures; special protection information; and special precautions required for materials manufactured for use. It is the manufacturer's responsibility to provide this information to the user for any materials that contain hazardous or potentially hazardous ingredients. Each employee is to be made aware that the MSDSs are available. The project and subcontractors shall maintain copies of all MSDSs for chemicals brought on-site and shall have them readily available.

7.9.2 Chemical Inventory

A hazardous material inventory of all chemicals brought on-site will be maintained by the appropriate hazardous material custodian. Prior to bringing hazardous materials on-site, personnel/subcontractors must submit an MSDS and receive approval from the facility manager and safety and health specialist.

It is the responsibility of the user to ensure that all potentially hazardous materials taken to a project site are properly labeled as to the contents of the container and with the appropriate hazard warnings.

7.10 EMERGENCY MANAGEMENT

In the event of an emergency, all site personnel shall follow the requirements and provisions of the PGDP Emergency Management Plan. Emergency response shall be provided by the PGDP emergency response organization. The site superintendent and safety and health specialist will be in charge of personnel accountability during emergency activities. All personnel working on-site will be trained to recognize and report emergencies to the safety and health specialist or the site superintendent. The safety and health specialist or site superintendent will be responsible for notifying the PGDP emergency response organization.

The PGDP emergency response organization will be contacted for emergency response to time-urgent medical emergencies, fires, spills, or other emergencies. The plant shift superintendent (PSS) will coordinate 24-hour emergency response coverage. The requirements of this section will be communicated to site workers. Any new hazards or changes in the plan also will be communicated to site workers.

7.10.1 Potential Emergencies

Potential emergencies that could be encountered during this project include, but are not limited to, fires, spills, and personnel exposure or injury. An emergency response plan, which contains explicit instructions and information about required emergency actions and procedures, is located in the site-specific HASP and/or in the prime contractor's facilities.

7.10.2 Fires

In the event of a fire, the PSS shall be notified immediately. If it is safe to do so, and they are properly trained, on-site personnel may attempt to extinguish an incipient fire with the available fire extinguisher and isolate any nearby flammable materials. If there is any doubt about the safety of extinguishing the fire, all personnel must evacuate to an assembly location and perform a head count to ensure that personnel are accounted for and are safely evacuated. The site superintendent or designee will provide the fire department with relevant information.

7.10.3 Spills

In the event of a spill or leak, the employee making the discovery will immediately vacate the area and notify other personnel and his/her supervisor. The site superintendent or designee will determine whether the leak is an incidental spill or whether an emergency response is required. If there is a probability that the spill will extend beyond the immediate area, result in an environmental insult, or exceed the capabilities of the on-site personnel, the site superintendent is to inform the PSS, who will determine whether a response by the PGDP spill response team is warranted. If emergency response crews are mobilized, the site superintendent or knowledgeable employee will provide the responders with relevant information.

7.10.4 Medical Emergencies

Personnel with current first aid or first responder training will serve as the designated first aid provider. Any event that results in potential employee exposure to bloodborne pathogens will require a post-event evaluation and follow-up consistent with 29 *CFR* § 1910.1030. A person knowledgeable of the location and nature of the injury will meet the emergency response personnel to guide them to the injured person.

The PGDP emergency response organization will be contacted for emergency response to time-urgent medical emergencies, fires, spills, or other emergencies. Site personnel may take workers with injuries that are more severe than can be addressed by first aid, but that do not constitute a medical emergency, to designated medical facility. The site superintendent, safety and health specialist, and GWOU project manager must be informed immediately that the worker has been taken to the medical facility and the nature of the injury.

7.10.5 Reporting an Emergency

Project personnel will be able to communicate by two-way radio, plant radio, or cellular telephone on-site.

7.10.6 Telephone

Inside the PGDP security perimeter, if a plant telephone is accessible, dial 6333. With a cellular phone, dial 270-441-6333. Describe the type and the location of the emergency. Identify who is calling. Identify the number on the phone being used. Tell whether an ambulance is needed. Listen and follow any instructions that are given. Do not hang up until after the Emergency Control Center has hung up.

7.10.7 Fire Alarm Pull Boxes

Pulling a fire alarm box at PGDP automatically transmits the location of the emergency to the fire department and the Emergency Control Center. The person pulling the alarm should remain at the alarm box, or nearest safe location, and supply any needed information to the emergency responders. Work personnel should note the location of pull boxes in each project area, where applicable.

7.10.8 Radio

Channel 16 is designated as the emergency channel on the plant radio system. By calling radio call number Alpha 1 and declaring “EMERGENCY TRAFFIC, EMERGENCY TRAFFIC,” the PSS is alerted of the emergency. Describe the type and the location of the emergency as well as who is calling.

7.11 ALARM SIGNALS

7.11.1 Project-Specific Alarm

A prolonged blast of an air horn or vehicle horn will signal immediate work stoppage and evacuation to a pre-designated area.

7.11.2 Evacuation Alarms

PGDP facility evacuation alarms are denoted by a steady or continuous sound from the site public address system. Proceed to the predetermined assembly station. The assembly station director will provide further instruction.

7.11.3 Radiation Alarms

PGDP radiation alarms are denoted by a steady sound from a clarion horn and rotating red beacon lights. Evacuate the site or area and proceed to the predetermined assembly station. The assembly station director will give further instruction.

7.11.4 Take-Cover Alarms

PGDP take-cover alarms are denoted by an intermittent or wailing siren sound from the site public address system. Seek immediate protective cover in a strong sheltered part of a building. Evacuate mobile structures to a permanent building or underground shelter.

7.11.5 Standard Alerting Tone

The standard alerting tone at PGDP is a high/low tone from the public address system and is repeated on the plant radio frequencies. Listen carefully; an emergency announcement will follow.

7.11.6 Evacuation Procedures

The safety and health specialist or site superintendent will designate the evacuation routes. Every on-site worker should familiarize himself/herself with the evacuation routes. In the event of an evacuation, proceed to the predetermined assembly station or designated area and wait for further instructions.

7.11.7 Sheltering In Place

Certain emergency conditions (e.g., chemical or radioactive material release, tornado warning, fire, security threat) may require that personnel be sheltered in place. Notification of a recommendation of "sheltering in place" is carried out by the PGDP emergency director on the emergency public address system and plant radio frequencies. Requirements for "sheltering in place" follow these steps:

- Go indoors immediately;
- Close all windows and doors;
- Turn off all sources of outdoor air (e.g., fans and air conditioners);
- Shut down equipment and processes, as necessary for safety; and
- Remain indoors and listen for additional information on radios and/or the public address system.

7.11.8 On-Site Relocation

Certain emergency conditions (e.g., chemical or radioactive material release, tornado warning, fire, security threat) may require that on-site personnel be relocated from their normal workstations and activities to locations more suitable to withstand the threat. Notification of on-site relocation is carried out by the PGDP emergency director on the public address system and plant radio frequencies. Specific instructions about where to relocate will be given with the message.

7.11.9 Facility Evacuation

For evacuations related to emergencies inside PGDP, the PGDP emergency director initiates notification of facility evacuation over the public address system. Assembly stations serve as gathering points for evacuating personnel. In the event of an evacuation alarm, employees will evacuate to the designated assembly point for the area and immediately report to the site superintendent or the assembly station director. An accounting will be conducted of all personnel who have evacuated. Further instructions and information about the emergency situation will be given to employees by the assembly station director or over the site public address system and plant radio.

7.11.10 Emergency Equipment

The following items of emergency equipment will be maintained at the work location:

- Hard-wired or cellular telephone and radios;
- First aid kit including bloodborne pathogen PPE;
- ABC-rated fire extinguishers; and
- Basic spill kit suitable to handle small spills.

7.12 HEAT AND COLD STRESS

Common types of stress that affect field personnel are from heat and cold. Heat stress and cold stress may be one of the most serious hazards to workers at hazardous waste sites. In light of this, it is important that all employees understand the signs and symptoms of potential injuries/illnesses associated with working in extreme temperatures.

7.12.1 Heat Stress

Heat stress occurs when the body’s physiological processes fail to maintain a normal body temperature because of excessive heat. The body reacts to heat stress in a number of different ways. The reactions range from mild (such as fatigue, irritability, anxiety, and decreased concentration) to severe (such as death). Heat-related disorders are generally classified in four basic categories: heat rash, heat cramps, heat exhaustion, and heat stroke. The descriptions, symptoms, and treatments for these diseases are described in the following sections.

7.12.2 Heat Rash

Description. Heat rash is caused by continuous exposure to heat and humid air and is generally aggravated by coarse clothing. This condition decreases the body’s ability to tolerate heat, but is the mildest of heat-related disorders.

Symptoms. Mild red rash generally is more prominent in areas of the body in contact with PPE.

Treatment. Decrease the amount of time in PPE and use powder to help absorb moisture.

7.12.3 Heat Cramps

Description. Heat cramps are caused by perspiration that is not offset by adequate fluid intake. This condition is the first sign of a situation that can lead to heat stroke.

Symptoms. Acute, painful spasms of the voluntary muscles (e.g., abdomen and extremities).

Treatment. Remove victim to a cool area and loosen clothing. Have victim drink one to two cups of water immediately and every 20 minutes thereafter until the symptoms subside. Consult a physician.

7.12.4 Heat Exhaustion

Description. Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is more severe than heat cramps.

Symptoms. Pale, clammy, moist skin with profuse perspiration and extreme weakness are the symptoms. Body temperature is generally normal, but the pulse is weak and rapid. Breathing is shallow. The victim may show signs of dizziness and may vomit.

Treatment. Remove the victim to a cool, air-conditioned atmosphere. Loosen clothing and require the victim to lie in a flat position with the feet slightly elevated. Have the victim drink one to two cups of water immediately and every 20 minutes until the symptoms subside. Seek medical attention, particularly in severe situations.

7.12.5 Heat Stroke

Description. Heat stroke is an acute, dangerous situation. It can happen in a very short time. The victim's temperature control system shuts down completely, resulting in a rise in body core temperature to levels that can cause brain damage and can be fatal if not treated promptly and effectively.

Symptoms. Red, hot, dry skin, with no perspiring. Rapid respiration, high pulse rate, and extremely high body temperature.

Treatment. Cool the victim quickly. If the body temperature is not brought down quickly, permanent brain damage or death can result. The victim should be soaked in cool water. Get medical attention as soon as possible.

7.12.6 Preventive Measures

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

- Acclimate employees to working conditions by slowly increasing workloads over extended periods of time. Do not begin site work activities with 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 tempered water and encourage them to drink it throughout the work shift; discourage the use of alcohol during nonworking hours. It is essential that fluids lost through perspiration be replenished. Total water consumption should equal 1 to 2 gal/day.

- During hot periods, rotate employees wearing impervious clothing.

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

7.12.7 Heat Stress Monitoring

For strenuous field activities that are part of ongoing site activities in hot weather, physiological monitoring may be used to monitor the individual's response to heat. Physiological monitoring will be implemented in accordance with PAD-IH-5134, *Temperature Extremes*. The guidelines set forth in the current issue of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values and Biological Indices shall be used to determine the work/rest regimen for working in environments conducive to heat stress.

7.12.8 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, symptoms, and treatments for frostbite and hypothermia are provided below.

7.12.9 Frostbite

Description. Frostbite is a condition in which the fluids around the cells of body tissues freeze, damaging the tissues. The most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes.

Symptoms. Affected areas become white and firm.

Treatment. Get the individual to a warm environment and rewarm the areas quickly. Keep affected areas covered and warm. Warm water can be used to thaw the areas.

7.12.10 Hypothermia

Description. As the temperature of the body drops, the thermoregulatory system attempts to increase the body's generation of heat, blood vessels are constricted to conserve energy, and glucose is produced to increase the body's metabolic rate (i.e., glucose is used as fuel to generate heat).

Symptoms. Uncontrollable shivering with the sensation of cold. Slower heartbeat and weaker pulse.

Treatment. Get individual to a warm environment.

7.12.11 Preventive Measures

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. Warm drinks or soups should be readily available.

- The skin should not be continuously exposed to subzero temperatures.

7.12.12 Cold Stress Monitoring

Air temperature alone is not a sufficient criterion on which to judge the potential for cold-related disorders in a particular environment. Heat loss from convection (air movement at the surface of the skin) is probably the greatest and most deceptive factor in the loss of body heat. For this reason, wind speeds as well as air temperatures need to be considered in the evaluation of the potential for cold stress disorders. The ACGIH Threshold Limit Values and Biological Indices provide additional guidance on cold stress evaluation and the establishment of the work/rest regimen in environments conducive to cold stress.

7.13 HOUSEKEEPING

Work zones shall be picked up and wastes and debris will be properly stored. Tools, materials, welding leads, hoses, or debris shall not be strewn about in a manner that may cause tripping or other hazards. Stored material shall be placed and otherwise secured against sliding or collapse. All slip, trip, and fall hazards will be eliminated or adequately barricaded or marked.

7.14 HEARING CONSERVATION

- Exposures to noise levels greater than 85 decibels (dBAs) (A-weighting filter) will require hearing protection.

- Noise reduction ratings of hearing protection must be sufficient to reduce exposure to less than 85 dBAs.

- No unprotected exposure to noise levels greater than 115 dBAs will be allowed.

- Employees exposed to noise in excess of a time-weighted average of 85 dBAs must have annual audiograms.

- Engineering controls shall be used when possible to restrict noise to less than 85 dBAs.

- Areas with noise levels above 85 dBAs will be posted.

7.15 PERSONNEL DECONTAMINATION

Decontamination procedures will vary with different stages of work and with work conditions. The safety and health specialist and radiation control technician (RCT) will determine decontamination requirements to minimize potential for spread of contamination from work zones.

7.16 EXPOSURE MONITORING

Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and health hazards in order to determine the appropriate level of employee protection needed on-site.

7.16.1 Routine Air Monitoring Requirements

Air monitoring will be performed during the following activities:

- Intrusive activities such as drilling and opening sampling tubes are being done;
- Work begins on a different portion of the site;
- Contaminants other than those previously identified are being handled;
- A different type of operation is initiated; or
- Personnel are opening drums that contain material.

7.16.2 Site-Specific Air Monitoring Requirements

Measurements of airborne VOCs (primarily TCE) will be conducted in the work area during intrusive activities by using photoionization detector (PID) or equivalent. VOC monitoring primarily will be focused on the breathing zones of employees. Air monitoring results will be used to determine the effectiveness and/or need for control measures.

7.16.3 Time Integrated Sample Collection

Verification sampling will be completed for VOCs and potentially specific contaminants of concern. Integrated sampling methodology will be evaluated by the Industrial Hygiene Program Supervisor and may be revised during the course of work based on real-time monitoring/sampling results and changing site conditions.

7.17 RADIOLOGICAL PROTECTION

The radiological contaminant of concern is Tc-99. Due to varying levels of Tc-99 some work may be performed under an RWP.

7.17.1 Radiation Protection Plan

All workers will operate under the DOE-approved Radiological Protection Program (RPP) when performing activities where a potential hazard is posed by radiation exposure. The DOE contractor will assess all radiological hazards that may be encountered. This has been accomplished primarily through the preparation of the HASP and the work control process. Based on these evaluation activities, appropriate engineering, administrative, and PPE controls will be selected and implemented. Whenever possible, work will be arranged to avoid (or at least minimize) entry into radiological areas. The radiation safety work practices focus on establishing controls and procedures for conducting work with radioactive material, while maintaining radiation exposures as low as reasonably achievable (ALARA).

All work associated with radiological issues will be conducted in accordance with the RPP, and, as a result, the DOE contractor will provide radiological support activities with potential radiation exposure. RCTs also may perform surveys and monitoring, identify radiological areas, and implement RWPs. All personnel/subcontractors will implement and maintain any controls identified as a result of these activities.

7.17.2 Contractor/Subcontractor Responsibilities

The DOE contractor and subcontractor responsibilities may include the following:

- Provide and erect any radiological barriers, barricades, warning devices, or locks needed to safely control the work site.
- Follow the requirements of the RWPs, including daily briefings, and requirements for signing in on all RWPs.
- Submit bioassay samples and use external dosimeters.
- Notify the GWOU project manager after any employee declares a pregnancy.
- Establish radiation control measures that comply with the requirements specified by radiological personnel supporting the project.
- Determine required radiological PPE based on appropriate work processes and AHAs.

7.17.3 Site-Specific Radiation Safety Work Practices

The DOE contractor and all subcontractors will implement the following radiation safety work practices when working in radiological areas.

- All personnel will adhere to the action levels and hold points identified in the RWP addressing the potential radiological hazards posed by work activities. Work practices and PPE will be altered according to changing radiological requirements as prescribed by the RWP and/or the RCT.
- All work activities to be performed will be designed and performed ensuring minimization of material brought into the Radiological Areas. Management, design engineers, and field personnel will jointly identify the materials and equipment needed to perform this work. Only equipment and supplies necessary to successfully accomplish the various tasks to be performed will be taken into the EZ. Work also will be planned and conducted in a manner that minimizes the generation of waste materials. All activities will be designed, before commencement of field activity to maintain radiation exposures and releases ALARA. Emphasis will be placed on engineering and administrative controls over the use of PPE, when feasible.
- All personnel working in, or subject to, work in the Radiological Areas will read the applicable RWP. The RCT or the safety and health specialist also will verbally review the RWP during the initial prework safety briefing. The site superintendent, the RCT and the safety and health specialist will continuously monitor worker compliance with the RWP. The site superintendent and/or the safety and health specialist will communicate changes to the RWP immediately to all affected personnel, and

work practices will be changed accordingly. Radiological controls specified by the RWP, such as PPE and work activity hold points, will be reviewed during preshift briefings.

- Engineering and administrative controls will be utilized to minimize and control the spread of airborne and surface contamination. If airborne contamination is identified, water mist will be used to eliminate or reduce this hazard. The contaminated water will be contained by plastic sheeting covering the work area. Surface contamination, in the form of waste, will be properly containerized throughout the project.

- Personnel will be instructed in the proper use and care of external dosimeters before commencement of field activities and periodically during prework tailgate briefings. Personnel will be instructed to wear the dosimeters only during activities posing an occupational ionizing radiation exposure. This will include all field activities. Personnel will be instructed to wear their dosimeters outside of company clothing in the front torso area of the body. They are not to expose the dosimeters to excessive heat or moisture. Dosimeters must be exchanged on a quarterly basis.

- All personnel will participate in the DOE contractor bioassay program. All personnel may be required to submit a baseline bioassay sample before receiving an external dosimeter and participating in any fieldwork. Periodic bioassays also will be submitted in a timely manner as directed by the radiological control organization. Personnel not complying with these requirements will be subject to removal from the project.

- The site superintendent and the safety and health specialist will conduct a continuous observance of work in progress and of field personnel performance with respect to ALARA. Additional reviews of performance will be discussed during “tailgate” safety meetings with all field personnel.

- Applicable lessons learned will be reviewed with personnel during the project. Work practices will be modified to incorporate lessons learned.

7.17.4 Radiation Safety Training

The DOE contractor and all personnel will observe the radiological training requirements, which require GET and Radworker II Training for all general employees who will perform hands-on work in radiological areas. The applicability of this training will be determined for each activity. Personnel, including visitors who are not necessary to the performance of the scope of work and who are not appropriately trained and qualified, will not enter any work areas where radiological exposures may occur. In areas where visitors are essential or otherwise approved to be present, they will be restricted from Contamination Areas, High Contamination Areas, High Radiation Areas, Very High Radiation Areas, or Airborne Radiation Areas. In all other radiological areas, visitors may be present only if escorted by a qualified radiological worker and will perform no hands-on activities.

7.18 HOISTING AND RIGGING PRACTICES

All hoisting and rigging will meet the DOE contractor hoisting and rigging requirements, in PAD-ENG-0012, *Hoisting and Rigging,* as well as those applicable in OSHA 1926 Subpart H, Subpart N, Subpart O, Subpart CC, and OSHA 1910 Subpart N. Hoisting and rigging equipment will not be modified such that manufacturer’s specifications are invalidated.

In order to ensure that personnel are not injured or equipment is not damaged during hoisting and rigging operations, the following safe working guidelines will be utilized. These guidelines include those outlined in OSHA and DOE Hoisting and Rigging Standard, DOE-STD-1090-2011. A competent person will be on-site during all lifting activities.

7.18.1 General

Hoisting and rigging activities will be reviewed to determine their classification according to the following:

- Critical Lifts
- Pre-engineered Production Lifts
- Ordinary Lifts
- Personnel Lifts

7.18.2 Hoisting

Only designated and qualified personnel will operate hoisting equipment. Hoisting operators will be in visual or radio contact with a flag person before and during every lift. If visual or radio contact is interrupted for any reason, the operator will stop the lift until full contact is restored.

- The equipment will be capable, within the manufacturer's specifications, of fulfilling all requirements of the work without endangering personnel or equipment.

- Equipment with outriggers will have the outriggers fully extended and set before all lifts.

- Before lifting, operators will know the total weight of the load.

- The operator will check the load line brake and crane for stability when the load is only inches from the ground. This lift of a few inches will be considered a "trial lift."

- A suspended load never will be left unattended. An operator will not leave the control station of a crane during a lift except under the conditions listed here.

- Personnel will not stand or pass under suspended loads.

- A tag line(s) will be used as necessary will be used to adequately control the load while landing.

- A crane load chart for the crane, as configured, will be posted in the cab of each crane, along with the rated load capacities, recommended operation speeds, and special hazard warnings or instructions.

- Cranes will be inspected in accordance with the guidelines provided below:

  — Applicable American Society of Mechanical Engineers (ASME) B30-series daily, monthly, quarterly, semiannual, annual, and special inspections will be completed before any crane is operated.

  — The annual certification sticker will be prominently displayed on the crane, but in such a manner that it does not obstruct the operator's view of any work operation.

  — Borrowed, rented, or leased cranes will be inspected before on-site use by the qualified crane inspector regardless of any other signed inspection forms.

- Hoisting and rigging equipment associated with drilling operations are subject to visual on-site hoisting and rigging hardware/device inspections by the DOE contractor. Drill rig hoisting and rigging equipment will be inspected prior to its use by a competent person. Operations will be suspended if not in compliance with OSHA, DOE, or PAD-ENG-0012, *Hoisting and Rigging*.

7.18.3 Rigging

- Rigging equipment for material handling will be visually inspected before use and as necessary during its use to ensure that it is safe. Defective rigging equipment will be removed from service immediately. Inspections will be performed by a competent person who, by training or experience, can recognize defects and take appropriate action to correct them. Periodic inspection of rigging equipment will be performed and documented on a written checklist, signed, and dated. Periodic inspections are not to exceed one year. Defective rigging equipment shall be removed from service per PAD-SH-2001, *Identifying Defective Equipment.*

- Rigging equipment will be identified and marked in accordance with ASME B30 series. Rigging equipment will not be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 of OSHA 29 *CFR* § 1926 Subpart H (29 *CFR* § 1926.251, "Rigging Equipment for Material Handling").

- Rigging equipment will be stored in designated areas where it will not be exposed to mechanical damage, corrosive material, moisture, kinking, or extreme temperatures.

- Any non-off-the-shelf, below-the-hook lifting device (lift beam, spreader, rod-clamp, etc.), rigging apparatus, or component shall be designed, constructed, tested, and inspected in accordance with ASME B30.20.

8. SAMPLING AND ANALYSIS

8.1 PHASE IIa BASELINE AND POSTOPERATION SAMPLING AND ANALYSIS PLAN

The Project Team will perform sampling work in accordance with contractor-approved procedures and work instructions. Procedures related to the sample collection are listed below. Additional procedures are referenced in Section 4, Table 4.

- PAD-ENM-0018, *Sampling Containerized Waste*
- PAD-ENM-0021, *Temperature Control for Sample Storage*
- PAD-ENM-0023, *Composite Sampling*
- PAD-ENM-2300, *Collection of Soil Samples*
- PAD-ENM-2303, *Borehole Logging*
- PAD-ENM-2700, *Logbooks and Data Forms*
- PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*
- PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation*
- PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*
- PAD-ENM-5003, *Quality Assured Data*
- PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*
- PAD-WD-9503, *Off-Site Shipments by Air Transport*

8.1.1 Purpose

This plan describes soil sampling to support analysis of the percent reduction of VOCs as a result of the C-400 IRA. Phase IIa baseline and postoperational TCE and TCE degradation product concentrations will be used as an indicator of the reduction of these VOCs.

The Phase IIa ERH electrode array consists of 52 electrode locations to address the southeast treatment area of C-400. Select electrode borings will be used to collect soil samples to determine the concentrations of TCE and TCE degradation products in the soil prior to the operation of the ERH electrodes. Phase IIa will also incorporate additional soil boring locations to address lessons learned from Phase I operations. For example, Phase I did not incorporate baseline soil samples from areas centrally located between the ERH electrode arrays. As a consequence, additional confirmatory soil samples were collected from two areas centrally located between Phase I electrodes. This was done to evaluate VOC concentrations in those areas not directly proximal to electrode locations. Collocated samples collected from adjacent soil borings will be used to determine the residual TCE concentrations subsequent to the operation of the Phase IIa ERH electrodes.

Postoperational groundwater samples will be collected from the upper RGA at the completion of Phase IIa. The groundwater in these zones may reflect dissolved-phase TCE concentrations that indicate influence from lower portions of the aquifer.

8.1.2 Introduction to the Data Quality Objective Process

The data quality objective (DQO) process is a strategic planning approach based on the scientific method to prepare for a data collection activity. It consists of the seven key elements listed as follows:

- State the Problem
- Identify Decisions
- Identify Inputs
- Specify Boundaries
- Define Decision Rules
- Specify Error Tolerances
- Optimize Sample Design

The DQO process, as it applies to this sampling and analysis plan, is summarized in the following text.

State the Problem

The problem statement is as follows:

> The efficacy of the ERH method on VOC mass removal must be determined. In order to assess the effectiveness of ERH in its application in the soils south of the C-400 Building, soil samples will be collected and analyzed for a comparison of VOC levels in soil of the treatment area before and after application of ERH.

Phase IIa ERH treatment area is limited to UCRS and upper RGA soils between 20 ft and 60 ft bgs.

Soil samples will be used to obtain an indication of the presence of DNAPL. DNAPL will be present in the soil samples as sorbed mass and as free-phase DNAPL contained in the soil pores. Phase I lessons learned indicated that additional analytical data were needed between electrode locations; therefore, Phase IIa baseline/postoperation sampling events will collect a representative cross-section of samples from areas adjacent to electrode locations and areas centered between electrode locations. This optimized baseline/postoperations sampling plan will provide a more definitive comparison of VOC levels in the southeast treatment area.

The analytes for soil samples that will support the assessment of the percent reduction for the C-400 remedial action are TCE and its intermediate, reductive dechlorination[4] degradation products. These are as follows: 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride. These analyses will be performed using method SW-846, with a reporting limit of 10 µg/kg per analyte for soils. These samples will be planned through the Paducah Sample Management Office (SMO) and sent to a SMO-approved laboratory that has been audited under the DOE–Consolidated Audit Program (DOECAP), and if required, is certified by Kentucky Department for Environmental Protection (KDEP) to perform the requested analyses.

Identify Decisions

The principal study question and associated alternative actions and decision rule typically are identified in this section; however, no decisions within the scope of this IRA will be made with the data. Rather the data will be analyzed to indicate the percent reduction in the VOC concentrations in the area; therefore, only a principal study question will be defined in this section. It is inappropriate to define either alternative actions or a decision statement when no decisions are to be made with the data. The principal study question associated with this project is as follows:

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[4] Reductive dechlorination is not expected to be an active process in the aerobic soil of the treatment areas; however, lesser levels of these VOCs have been detected in samples of soil and groundwater from south of the C-400 Building. Intermediate products of other degradation pathways typically are short-lived.

What is the percent reduction in VOC levels in the southeast treatment area of the C-400 Cleaning Building Area?

Identify Inputs

The study inputs are identification and quantification of VOCs in soils in the area south of the C-400 Cleaning Building area prior to and after the implementation of ERH.

Specify Boundaries

The boundary of the study area is the DNAPL zone defined for subsurface soils between 20-ft and 60-ft deep near the southeast corner of the C-400 Cleaning Building, as identified in Appendix A of the RDR (DOE 2008a). Soil cores will be collected from the Southeast Treatment Area from the UCRS and upper RGA units between the depths of 20 ft–60 ft bgs, during installation of select subsurface components.

Figure 4 depicts both Phase IIa and Phase IIb target treatment areas. Percent reduction in VOC levels will be calculated separately for each area. The collection of post-ERH soil samples will begin as soon as temperatures within the subsurface treatment zone decline to a safe level for sampling as determined by the *in situ* temperature monitoring system. It is anticipated that the sample collection will commence approximately one month after the end of ERH operation.

Define Decision Rules

The parameter of interest in this study is the mean difference in concentrations of VOCs prior to ERH operation and after ERH operation. These values will be used as an indicator of the percent reduction in VOC levels due to ERH. Because no decision will be made regarding this data, it is inappropriate to define decision rules.

Specify Error Tolerances

This step of the DQO process includes the development of statistical hypotheses, decision rules, and the definition of appropriate error rates and decision errors. The overall effectiveness of the treatment system will be evaluated by comparing soil analyses of the pretreatment sampling results to the posttreatment sampling results from the treatment area. An upper and lower bound for the pretreatment and post-treatment concentration values from the soil samples from the Southeast Treatment Area for each of the detected VOCs (e.g., TCE, *cis*-1,2-DCE, vinyl chloride) will be estimated by establishing a 90% confidence interval for the variance for each treatment area. After the intervals have been constructed, the upper tolerance level for the pretreatment sampling results will be compared by inspection with the upper tolerance level for the posttreatment sampling result within the treatment area (for each VOC) as one measure of the effectiveness of the IRA. The assessment of the reduction of VOCs will report the error tolerances of the data set for each treatment area.

Optimize Sampling Design

This step is used to optimize sampling design. Sample locations were distributed across the Southeast Treatment Area based on professional judgment. The derived number of sample locations was independent of assumptions that would be required to support a statistical evaluation.

The distribution of DNAPL in subsurface soils is extremely heterogeneous and varies in response to depositional/erosional structures; textures resulting from subsequent chemical, physical, and biological processes; and the location, mass, and timing of the DNAPL release(s). TCE was the primary contaminant released into the soils south of the C-400 Cleaning Building. Subsequent degradation has resulted in lesser levels of other VOCs within the DNAPL. It is anticipated that VOC levels in soils collected from the pre-ERH operation period will vary significantly across the treatment areas and that the comparable, post-ERH operation period VOC levels will exhibit much less variability. The average and median of the measured VOC reductions[5] will be used as indicators of the removal effectiveness of the C-400 remedial action. While the mass of VOCs that is removed will be determined, the mass of VOCs that is present in the treatment areas prior to ERH operation can be approximated only poorly. The average of the VOC reductions in collocated samples will assess the overall efficiency of the ERH operations, while the median of the VOC reductions in collocated samples will assess the typical efficiency of the ERH operations within the volume of the treatment zone.

The C-400 Building has been the site of numerous chemical and operational processes in support of the plant. Sample analyses from a previous remedial investigation of the C-400 area identify polychlorinated biphenyls (PCBs) and semivolatile organic compounds (SVOCs) as possible co-contaminants associated with the DNAPL source zones at PGDP. Each of the soil samples collected for characterization of postoperational VOC levels also will be analyzed for PCB and SVOC levels.

Sample locations are based on a hexagonal grid design; however, not all of the locations on the hexagonal grid will be sampled. The sample locations were determined by judgment, biased to the interior of the treatment areas where the VOC mass is anticipated to be greater. These analyses likely will provide a more significant measure of the removal effectiveness of the C-400 remedial action. Some sample locations have been retained on the perimeter of the treatment areas to assess removal effectiveness in these areas. Sample locations are documented in the following section.

8.1.3 Locations

8.1.3.1 Soil

Baseline soil sampling will be performed in accordance with procedure PAD-ENM-2300, *Collection of Soil Samples.* Figure 6 depicts proposed sample locations for the baseline sampling event. Baseline samples are being collected from electrode and digiTAM construction borings, where possible, to minimize drilling through the area of contamination. Soil core from a rotary sonic and/or direct push technology (DPT) drill rig will be sampled to characterize baseline VOC levels. The drill rig will collect soil core in a plastic liner that will be cut open for soil sampling once the liner has been extracted. After scanning the soil for hazardous radiation levels, the core will be characterized for VOC occurrences with a PID (ppbRAE or equivalent). This method provides a continuous field scan of the soil core at 0.5 ft-depth intervals. A soil sample then will be collected from the core in the area with the highest PID results using an EnCore sampler. This will result in one sample per designated depth interval as described in Table 6.

Postoperations soil sampling will be performed in accordance with procedure PAD-ENM-2300, *Collection of Soil Samples.* Figure 7 depicts proposed sample locations for the postoperations sampling event. Several electrode locations (primarily on the perimeter of the treatment area) will not be sampled for postoperation characterization. Results from Phase I operations demonstrated that treatment at or immediately adjacent to electrode borings is expected to result in significant reductions (95% or greater during Phase I) in TCE levels at these locations. Phase IIa postoperational sampling will be focused near the centroids between electrodes, which represent potential zones where the subsurface soils may receive

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[5] The VOC reduction will be calculated for each pair of collocated samples by subtracting from one the fraction derived by dividing the post-ERH operation VOC level by the pre-ERH operation VOC level.

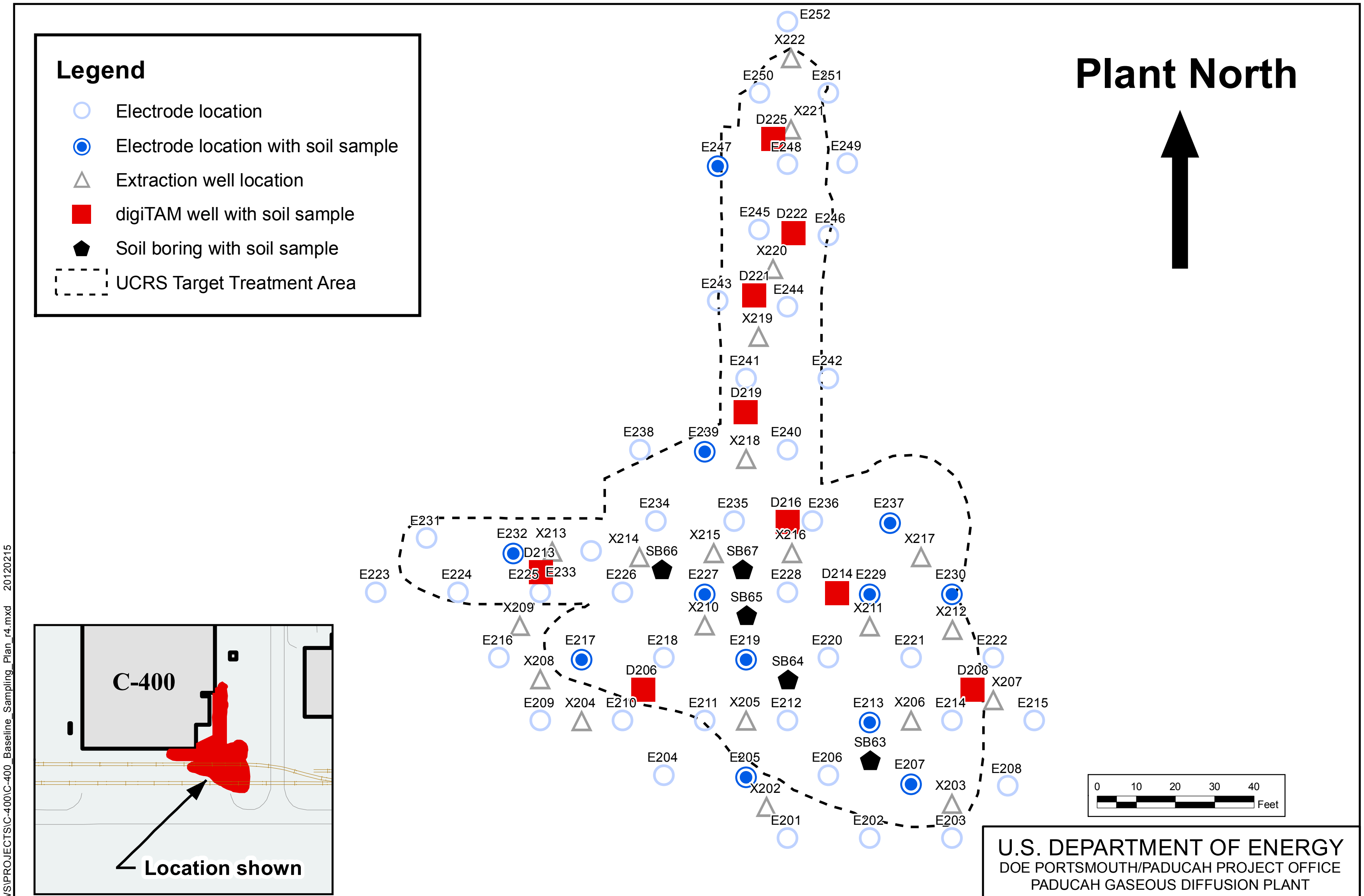

Figure 6. Planned Baseline Soil Sample Locations for the Phase IIa Treatment Area

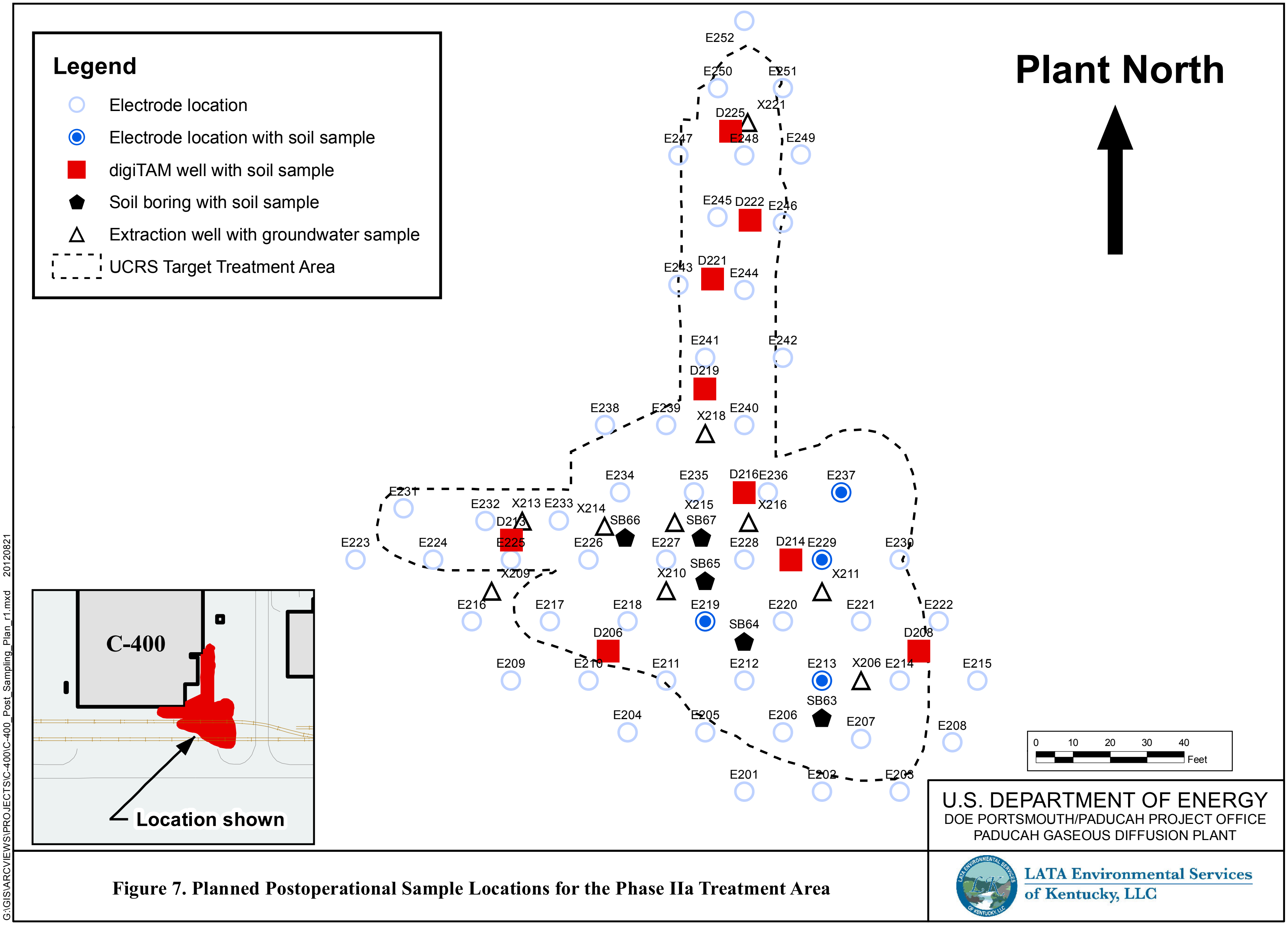

Figure 7. Planned Postoperational Sample Locations for the Phase IIa Treatment Area

less influence from the ERH treatment system (i.e. less heat and vacuum). Additional postoperational confirmatory samples may be collected from these baseline electrode locations if postoperational analytical data indicate a need to do so. Collection of postoperation soil samples will be performed soon after subsurface temperatures decline below 100ºC (approximately one month after ERH operation ends) using a DPT sample system. The DPT soil samples will be collected in stainless steel liners. High residual heat of soil samples collected after ERH operation presents additional challenge to the samplers. Postoperation soil sampling will be performed in accordance with procedure PAD-ENM-2300, *Collection of Soil Samples,* with the additional steps that follow. The following steps for high temperature soil sampling will be used to supplement contractor sampling procedures.

- The field crew will cap and seal (with a silicone based tape) the ends of the stainless steel liners and submerge them in an ice bath to lower the soil temperature and minimize the off-gassing of VOCs[6] before collecting the sample.

- The stainless steel liner will be removed from the bath, and the samplers will remove the end seals, extrude the core, and collect the sample following contractor sampling procedures.

- If the DPT system is not able to complete the postoperation sampling to the required depth, then appropriate drilling techniques, such as hollow stem auger, will be deployed for collection of these soil samples in accordance with PAD-ENM-2300, *Collection of Soil Samples*.

Soil samples are being collected in the shallow, middle, and deep UCRS and upper RGA in all but the three northern-most sample locations (D222, D225, and E247). In the area of these three borings, where previous characterization data from the WAG 6 RI indicates that VOC contamination is limited to the shallow soils only, the soil samples are scheduled for the shallow and middle UCRS only. In the UCRS and upper RGA cores, the selection of the sample interval will be biased to characterize zones of highest VOC level, as determined by field monitoring instruments (e.g., PID). In the upper RGA core, sand intervals with high VOC levels will be selectively sampled. A sand matrix is more readily sampled, especially with DPT, and analyzed than the gravels common to the RGA. In the UCRS and upper RGA cores, a grab sample from the selected sample interval will be collected as soon as possible after the core liner is opened, without compositing a sample. EnCore samplers will be used to sample the core, packing the sample in a 5 gm EnCore sample vial with septum seal. Samples will be preserved by cooling them to 4°C ± 2°C in a sample cooler or refrigerator.

The selected locations for the collection of soil samples address the full areal and vertical extent of the TCE contamination, with a bias to characterization of the centroids of contamination. For the purpose of defining sampling intervals, the TCE soil contamination is defined as shallow, middle, and deep UCRS and upper RGA. This plan specifies the collection of soil samples from all heated intervals in 26 selected locations and from shallow zones from 1-20 ft bgs. Table 6 summarizes the distribution of the selected sampling intervals.

The characterization plan specifies 96 baseline soil sample locations and 68 postoperation sample locations. Table 7 provides further details of the soil sample intervals. The field sampling crew will use VOC scans (e.g., PID) of the soil cores to target sand intervals with the highest VOC levels for sampling.

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[6] It is anticipated that VOC vapors will condense inside the sample and will be captured in the laboratory sample.

Table 6. Soil Sampling Summary

CONTAMINATION AREA	TOTAL # of BORINGS	UCRS					RGA
		SHALLOW			MIDDLE	DEEP	UPPER
		(0–10 ft bgs)	(10-20 ft bgs)	(20–30 ft bgs)	(30–40 ft bgs)	(40–52 ft bgs)	(52–60 ft bgs)
Baseline Southeast	26	25	25	25	25	23	23
Postops Southeast	18	18	18	18	18	16	16

Table 7. Design of the Soil Sampling Plan

BASELINE SAMPLE LOCATION	AREA	PLANNED POSTOPS SAMPLE LOCATION	ADJACENT MIP LOCATIONS	SAMPLE DEPTH INTERVAL					
				UCRS					RGA
				Shallow (0–10 ft bgs)	Shallow (10–20 ft bgs)	Shallow (20–30 ft bgs)	Middle (30-40 ft bgs)	Deep (40-52 ft bgs)	Upper (52-60 ft bgs)
D206*	Southeast	X		X	X	X	X	X	X
D208*	Southeast	X		X	X	X	X	X	X
D213*	Southeast	X		X	X	X	X	X	X
D214*	Southeast	X		X	X	X	X	X	X
D216*	Southeast	X		X	X	X	X	X	X
D219*	Southeast	X		X	X	X	X	X	X
D221*	Southeast	X		X	X	X	X	X	X
D222*	Southeast	X		X	X	X	X	--	--
D225*	Southeast	X		X	X	X	X	--	--
E205	Southeast		MIP-17	--	--	--	--	X	X
E207	Southeast		MIP-25	X	X	X	X	X	X
E213	Southeast	X		X	X	X	X	X	X
E217	Southeast		MIP-13	X	X	X	X	X	X
E219	Southeast	X	MIP-16	X	X	X	X	X	X
E227	Southeast			X	X	X	X	X	X
E229	Southeast	X		X	X	X	X	X	X
E230	Southeast			X	X	X	X	X	X
E232	Southeast			X	X	X	X	X	X
E237	Southeast	X	MIP-50	X	X	X	X	X	X
E239	Southeast			X	X	X	X	X	X
E247	Southeast			X	X	X	X	--	--
SB63*	Southeast	X		X	X	X	X	X	X
SB64*	Southeast	X		X	X	X	X	X	X
SB65*	Southeast	X		X	X	X	X	X	X
SB66*	Southeast	X		X	X	X	X	X	X
SB67*	Southeast	X		X	X	X	X	X	X

* Sample locations centered between electrodes

8.1.3.2 Groundwater

Details regarding sampling of groundwater from Phase IIa extraction wells during operation will be provided in an operations and maintenance plan. Results from Phase I indicate that source material in the UCRS and upper RGA will be effectively treated using ERH. After conclusion of Phase IIa operations, it is anticipated that ambient hydraulic conditions will be reestablished, and groundwater in these zones may reflect dissolved-phase TCE concentrations that indicate influence from lower portions of the aquifer. It is not anticipated that source material will migrate into the Phase IIa treatment zone. Postoperational groundwater samples will be collected from the upper RGA within and downgradient of the Phase IIa treatment zones. Groundwater samples will be collected for analysis of VOCs in 40-mL glass vials with Teflon-lined closure, filled so that no headspace remains in the vial. Samples will be preserved with hydrochloric acid to a pH of less than 2 and cooled to 4°C ± 2°C. High residual heat of groundwater samples collected after ERH operation presents additional challenge to the samplers. Postoperation groundwater sampling will be performed in accordance with procedure PAD-ENM-2101, *Groundwater Sampling*, with the following additional steps. The field crew will route the sample discharge stream through a coil of copper or aluminum tubing submerged in an ice bath to lower the groundwater temperature before collecting the sample.

Ten multiphase extraction wells have been selected for the collection of postoperational groundwater samples. These wells are part of a network of 22 multiphase extraction wells that provide for groundwater and vapor extraction during the ERH heating phase and allow collection of groundwater samples for characterization of dissolved TCE concentrations. Multiphase extraction wells X209, X213, X214, and X218 were selected as the best available locations to represent downgradient collection points. These wells are located adjacent to the downgradient limit of the target heating zone and should be reflective of groundwater in the treatment zone that is migrating downgradient. Due to the treatment zone configuration and the presence of the C-400 Building, it is not possible to establish monitoring wells immediately downgradient of the treatment zone. Prior to the collection of postoperational groundwater samples, the pneumatic groundwater extraction pumps will be raised from 68 ft bgs (base of pump) to 60 ft bgs to sample groundwater from the upper RGA (estimated at 52-60 ft. bgs).

Each of these wells will be sampled three times over a four-week period, after ERH operations have ceased, to establish the representative dissolved TCE and TCE degradation products concentrations for each well for the period. Figure 7 illustrates the spatial coverage of the postoperational groundwater sampling plan.

8.1.4 Monitoring

MW155 (lower RGA)/MW156 (upper RGA)/MW157 (UCRS) near the southeast corner of C-400 and MW405, MW406, MW407, and MW408 (lower, middle and upper RGA),[7] located on the east side of C-400, form a closely-spaced network of monitoring points just to the north of the DNAPL source zones and will provide information to assess near-term impact of the IRA on the dissolved-phase plume. Long-term assessment of the C-400 IRA impact on the groundwater plumes will be provided by sampling of existing wells and installation and sampling of new wells. RGA wells MW175 (screened 75–80 ft bgs), MW342 (screened 75–85 ft bgs), and MW343 (screened 75–85 ft bgs) and nested RGA wells MW421, MW422, MW423, MW424, and MW425 (each with screens at 71-73 ft bgs, 79-81 ft bgs, and 83-85 ft bgs) monitor the middle and lower RGA along the west side and northwest corner of C-400.

[7] MW405, MW406, MW407, and MW408 are multiport wells with well screens at depths of 36-38 ft bgs (UCRS—typically dry), 60–62 ft bgs, 66-68 ft bgs, 72–74 ft bgs, 80–82 ft bgs, 86–88 ft bgs (upper, middle and lower RGA), and 106–108 ft bgs (McNairy).

8.2 OPERATION AND MAINTENANCE SAMPLING

Throughout the treatment system start-up, testing, and routine operation, vapor and water samples will be collected and analyzed to assess the progress of the IRA, to monitor the aboveground treatment system effectiveness and to verify compliance with discharge criteria.

To assess the progress of the C-400 IRA, vapor samples will be collected from vapor extraction wells and vapor extraction headers coming from the treatment areas. Vapor samples will be collected periodically from various points in the vapor treatment stream to monitor the effectiveness of the treatment units. For example, samples will be collected from the lead vapor phase carbon vessel discharge to determine if and when a carbon change out should be performed. Compliance with discharge criteria will be monitored at the vapor treatment system stack. Vapor analyses will be performed using photoacoustic analyzers and periodically by a fixed-based laboratory.

Water samples will be collected from various sample ports throughout the groundwater treatment system in order to monitor the operational effectiveness of the treatment system. For example, results from water samples collected upstream of aqueous-phase carbon vessels will be compared to those from downstream of the carbon vessel to determine if and when a carbon change-out should take place. Samples will be collected routinely from the water treatment system effluent to monitor it for compliance with discharge criteria.

A Sampling and Analysis Plan (SAP) for operational sampling will be included in the O&M Plan to be developed and submitted for review in accordance with the planning schedule in Section 6 of this RAWP.

8.3 WASTE CHARACTERIZATION SAMPLING AND ANALYSIS PLAN

As discussed in the ROD (DOE 2005a), page A-5, a SAP is required as part of the WMP for waste characterization. This section serves as that SAP. 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, as required. Wastewater analyses will reference the applicable analytical requirements in PGDP's KPDES permit, Clean Water Act, or Safe Drinking Water Act. QA/QC requirements and data management requirements, as specified in Sections 9 and 10 of this document, will be followed for waste characterization sampling activities.

Characterization requirements and guidance are provided in the site waste acceptance criteria (WAC) and PAD-WD-0437, *Waste Characterization and Profiling*. Section 8.3.2 lists the analytical testing methods that will be used for analysis. The evaluation of the analytical results is discussed in Sections 9 and 10. The WMC will coordinate with the DOE prime contractor GWOU project manager and DOE contractor sample and data management group for required analyses and guidance on collection and transfer of characterization samples to a SMO-approved fixed-base laboratory that has been audited under DOECAP.

8.3.1 Contained-In/Contaminated-With Determinations

Some of the waste debris, other than PPE, and environmental media such as soil and groundwater generated during this project will be characterized and the results compared to health-based standards to determine whether any concentrations of TCE and 1,1,1-trichloroethane (TCA) are above health-based levels listed in Table 8. If the concentrations are below health-based levels, then the waste will be deemed not to contain or not to be contaminated with a Resource Conservation and Recovery Act (RCRA) listed waste (based on TCE/TCA content) for the purposes of management at the site.

Table 8. Health-Based Levels for TCE and 1,1,1-TCA

Constituent	Concentration in solids (ppm)	Concentration in aqueous liquids [parts per billion (ppb)]
TCE	39.2	30
1,1,1-TCA	2080	If aqueous liquids are below health-based level for TCE, then 1,1,1-TCA is declared below contained-in levels.

Because data from previous sampling events indicate that conditions for C-746-U Landfill disposal potentially will be met, characterization for C-746-U Landfill disposal will be undertaken at the same time as the sampling for the remedial action constituents. Land disposal restrictions (LDR) generally apply to media and debris generated from this project that no longer contain or are no longer contaminated with RCRA hazardous waste. If a contained in determination is made, the LDR is satisfied.

Health-based standards of 39.2 parts per million (ppm) TCE and 2,080 ppm 1,1,1-TCA in solids will be used as the criteria for making contained-in/contaminated-with determinations for environmental media and debris designated for disposal at the C-746-U Landfill. Solid wastes disposed of at landfills other than C-746-U will be subject to a contained-in/contaminated-with determination that will be approved by the Commonwealth of Kentucky and the state in which the receiving landfill is located. KDEP has agreed to consult with DOE and the state where the off-site facility is located to reach agreement on the appropriate health-based standard for making such determinations for waste that is to be shipped to such a facility. Aqueous environmental media waste contaminated with TCE or 1,1,1-TCA that do not qualify for the exemption cited herein will use a health-based concentration of 0.030 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES-permitted outfall. This self-implementing waste characterization and RCRA status determination will be used to decide on treatment requirements, if applicable, and the appropriate waste disposal facility for the waste. Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES Outfalls or on-site ditches that flow to permitted KPDES Outfalls.

In lieu of providing notification to KDEP as set forth in paragraph 63 of the October 3, 2003 *Agreed Order* (KNREPC 2003) (a procedural requirement), the contained-in/contaminated-with determination and supporting data will be documented in the post-ROD file and will be made available upon request.

8.3.2 Waste Characterization

Waste characterization sampling will be performed in accordance with procedure PAD-WD-0437, *Waste Characterization and Profiling.* Based on sample analyses, existing data, 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)
- Low-level waste (LLW)
- Mixed waste or
- Nonhazardous solid waste

Tables 9, 10, 11, and 12 list the analytical testing methods that will be used for analysis.

8.3.2.1 RCRA-listed hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA-listed hazardous waste is expected on this project. The waste is listed-hazardous due to the presence of TCE in the RGA underlying the majority of the area in which the soil borings and wells are to be installed. Waste generated during soil borings (i.e., drilling cuttings, purge water, sample residuals), 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 8. If the concentrations are below the levels contained in Table 8, then the waste will be deemed not to contain or not to be contaminated-with a RCRA listed waste (based on TCE/TCA content) for the purposes of on-site management. If the WAC is met, the waste will be properly disposed of in the C-746-U Landfill.

Aqueous environmental media waste contaminated with TCE or 1,1,1-TCA that does not qualify for the exemption cited herein will use a health-based concentration of 0.030 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES-permitted outfall. Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES Outfalls or on-site ditches that flow to permitted KPDES Outfalls.

Table 9. TCLP Parameters for Analysis of Solid Waste

Constituent	Method	TCLP Regulatory Limit (mg/L)	20 Times TCLP Regulatory Limit (mg/kg)
1,1-Dichloroethene	8240/8260	0.7	14
1,2-Dichloroethane	8240/8260	0.5	10
1,4-Dichlorobenzene	8270	7.5	150
2,4,5-TP (Silvex)	8150	1.0	20
2,4,5-Trichlorophenol	8270	400.0	8,000
2,4,6-Trichlorophenol	8270	2.0	40
2,4-D	8150	10.0	200
2,4-Dinitrotoluene	8270	0.13	2.6
Arsenic	7060/6010/6020	5.0	100
Barium	6010/6020	100.0	2,000

Table 9. TCLP Parameters for Analysis of Solid Waste (Continued)

Constituent	Method	TCLP Regulatory Limit (mg/L)	20 Times TCLP Regulatory Limit (mg/kg)
Benzene	8240/8260	0.5	10
Cadmium	6010/6020	1.0	20
Carbon tetrachloride	8240/8260	0.5	10
Chlordane	8081	0.03	0.6
Chlorobenzene	8240/8260	100.0	2,000
Chloroform	8240/8260	6.0	120
Chromium	6010/6020	5.0	100
Endrin	8081	0.02	0.4
Heptachlor	8081	0.008	0.16
Hexachlorobenzene	8270	0.13	2.6
Hexachlorobutadiene	8270	0.5	10
Hexachloroethane	8270	3.0	60
Lead	7421/6010/6020	5.0	100
Lindane	8081	0.4	8
Mercury	7470/6020	0.2	4
Methoxychlor	8081	10.0	200
Methylethylketone	8240/8260	200.0	4,000
Nitrobenzene	8270	2.0	40
Pentachlorophenol	8270	100.0	2,000
Pyridine	8270	5.0	100
Selenium	7740/6010/6020	1.0	20
Silver	6010/6020	5.0	100
Tetrachloroethene	8240/8260	0.7	14
Total cresol	8270	200.0	4,000
Toxaphene	8081	0.5	10
Trichloroethene	8240/8260	0.5	10
Vinyl chloride	8240/8260	0.2	4

Table 10. Analytical Parameters for Classification of Solid Waste as TRU, LLW, or PCB Wastes

Constituent	Detection limit	Method
Total uranium	150 pCi/g	Alpha Spectroscopy
Neptunium-237	3 pCi/g	Alpha Spectroscopy
Plutonium-239/240	3 pCi/g	Alpha Spectroscopy
Plutonium-238	3 pCi/g	Alpha Spectroscopy
Thorium-230/232	5 pCi/g	Alpha Spectroscopy
Technetium-99	500 pCi/g	Liquid Scintillation Counting
Cesium-137	5 pCi/g	Gamma Spectroscopy
PCB	0.1 mg/kg	8082

Table 11. Waste Characterization Requirements for Solid Waste

Constituent	Method
TCLP VOCs	SW-846 1311, 8260
TCLP SVOCs	SW-846 1311, 8270
TCLP metals	SW-846 1311, 6010/7470
TCLP pesticides	SW-846 1311, 8150
TCLP herbicides	SW-846 1311, 8150
Reactivity	SW-846 Section 7.3
Corrosivity	SW-846 1110
Moisture content	American Society for Testing and Materials (ASTM) D2216
Xylene	8260
Acetone	8260
Toluene	8260
Total cyanides	9010

Table 12. Waste Characterization Requirements for Decontamination, Development, and Purge Water

Parameter	Method	Detection Limit
Oil and grease	EPA 1664	10 mg/L
Total residue chlorine	Field Test	N/A
TCE	EPA 624	0.001 mg/L
1,1,1-TCA	EPA 624	0.001 mg/L
PCBs	EPA 608	varies by aroclor
Total uranium	EPA900/HASL-300[a]	30 pCi/L
Dissolved and suspended alpha	EPA900/HASL-300	15 pCi/L
Dissolved and suspended beta	EPA 900/HASL-300	50 pCi/L
Technetium-99	EPA 900/HASL-300	25 pCi/L
Total recoverable metals*	EPA 200.8/245.2	varies by metal
Total suspended solids	EPA 160.2	30 mg/L

[a] The procedure is derived from a variety of sources including, but not limited to, *Environmental Measurements Laboratory Procedures Manual* (DOE 1982) and *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980).

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

8.3.2.2 RCRA-characteristic hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA characteristic-hazardous waste is possible during this IRA. Any waste determined to be RCRA characteristic-hazardous waste will be treated in the same manner as RCRA listed-hazardous waste for storage and disposal requirements.

8.3.2.3 PCB wastes

If waste characterization analyses or additional process knowledge indicates the presence of PCBs in concentrations regulated under 40 *CFR* Part 761, then the wastes will be managed, transported, and disposed of in accordance with the requirement under that Part.

8.3.2.4 TRU wastes

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.

8.3.2.5 LLW

LLWs are described as any nonhazardous, non-PCB, or non-TRU waste containing radioactivity or other radionuclides in a concentration greater than authorized limits or the latest off-site release criteria and are not classified as high-level waste, TRU waste, spent nuclear fuel, or by-product material. LLW may be generated from materials removed from the Radiological Areas. All wastes from this project have the potential to be classified as LLW. The radiological contaminant of concern is Tc-99. Due to varying levels of Tc-99 some work may be performed under an RWP.

8.3.2.6 Mixed wastes

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

8.3.2.7 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.

8.3.3 Sampling and Analysis of Waste

The WMC will be responsible for sampling the solid and liquid waste as needed. During sampling, all appropriate health and safety concerns will be addressed. All samples will be screened for radioactivity based on the RWP and appropriate actions taken to prevent the spread of contamination. Sample materials from different containers will not be mixed unless they are from the same waste stream, and only containers requiring further characterization will be sampled. Samples will be assigned a unique identifier. The following text summarizes the waste characterization requirements. The sampling procedures for waste characterization are described in the following text.

8.3.3.1 Solid Waste

For solid wastes, the "20 times" rule will be used in accordance with *Use of Total Waste Analysis in Toxicity Characteristic Determinations* EPA 540/R-94-005a (EPA 1994), to determine if the waste is characteristically hazardous. That is, if the total concentrations of RCRA constituents are less than 20 times the Toxicity Characteristic Leaching Procedure (TCLP) limits in 40 *CFR* § 261.24, then the waste will be considered not to be characteristically hazardous. Where the total concentrations of RCRA constituents are greater than 20 times the TCLP limits, TCLP analyses will be performed to confirm the result.

Solid waste may be containerized in drums, ST-90 boxes, or 25 yd^3 intermodal (IM) containers during generation. The IM is the preferred container for solid wastes such as soil cuttings from drilling because it is the most reusable container and its greater size reduces both physical risk and cost by minimizing container movements as well as sampling activities. Solid waste may be sample prior to or after containerization.

In order to allow for lower analytical cost and timely disposal waste may be sampled prior to containerization using the following protocol, The samplers will perform soil sampling in accordance with procedure PAD-ENM-2300, *Collection of Soil Samples.* Soil core from a rotary sonic drill rig will be sampled to characterize baseline VOC levels. The rotary sonic drill rig will collect soil core in a flexible clear plastic liner that will be cut open for soil sampling once the liner has been extracted. To reduce sampling costs these baseline VOC samples will be used to characterize the containerized waste. A minimum of 5 VOC samples will be required to characterize each container. If the container is full prior to meeting the 5 VOC samples per container, additional VOC samples will be collected from the full container to assure this limit is met. The additional VOC samples will be collected using the protocol stated below for sampling of IMs. The samplers will document which ST-90 box or IM container the VOC sample represents. For metals and semivolatile organic analyte samples historical data from Phase I may be used for characterization. Five percent (1 in every 20) of the containerized waste will have confirmatory samples collected for these analytes. Radionuclides will be collected for each container. For radiochemical, metals, and SVOC samples, the samplers will use a stainless steel scoop or similar equipment to collect a representative sample of each soil core. This material will be consolidated with other soil material being loaded into a single ST-90 box or an Intermodal container. Once the all the material is consolidate for one container, the samplers will collect the required analytes.

If sampling is not performed prior to containerization the following protocol will be used. Additional information relative to management of waste in IM containers is provided in Section 12.2.2, and additional IM sampling information is provided below.

The waste sampling strategy for an IM is based on the following assumptions that allow the waste volume to be broken into five equal volume sections laterally:

- Waste typically is loaded from the center resulting in mounding toward the center.
- Approximate waste weight is 35,000 lb. Using a density of 90 lb/ft^3, this yields an assumed volume of 389 ft^3.

When keeping with these assumptions, the IM is broken into five sections each approximately 4.3-ft wide on the edges (2), 4.1-ft wide inside the edges (2), and a center section that is 3.3-ft wide. This results in five sections that are all approximately equal. Figure 8 shows a diagram of the approximate divisions.

One VOC sample will be taken from each of the five sections of the IM using an EnCore sampler (or an alternate method described in PAD-ENM-2300, *Collection of Soil Samples*) that is designed for VOC sampling. Per procedure, three EnCore samples will be used to represent a single sample point. Each sample point will be chosen randomly. This will result in five random and representative VOC samples per IM that have not been composited to minimize the loss of contaminants due to volatilization. Where waste in an IM is in excess of 35,000 lb, an additional randomly located VOC sample will be collected for each additional 7,000 lb (partial or full) of waste in the IM. Other methods, such as always performing VOC sampling first (prior to disturbing the waste with other sampling activities) will be employed to minimize VOC losses during sampling. Hold times and sample preservation will be performed in accordance with EPA method SW-846 8260. VOC laboratory results will be statistically evaluated and the 95% UCL at 2 sigma will be used to represent VOC concentrations in the IM.

For all parameters, except VOC samples, one core sample will be taken from the center of each of the 10 grids depicted in Figure 8 for composite sampling. These ten cores will be mixed individually and then equal volumes from each core will be composited into a single sample. This physically representative sample of the IM will be aliquoted for all parameters except VOCs.

Additional analyses to meet off-site disposal WAC also may be required and will be specified upon selection of the disposal site.

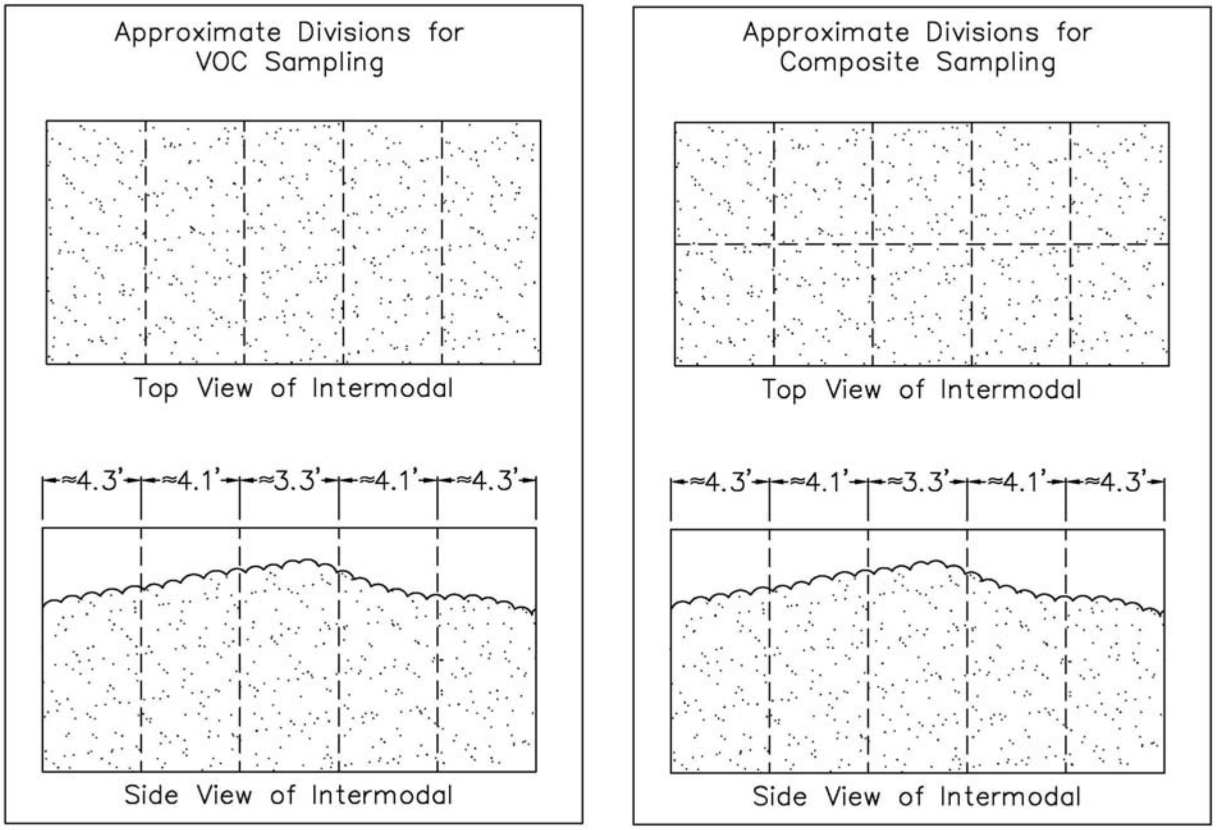

Figure 8. Approximate Division Locations for Intermodal Waste Sampling

8.3.3.2 Aqueous Waste

All liquid waste water samples will be collected directly from the 55-gal drums, 1,000-gal portable containers, or larger tanks, as applicable, which will be located in a CERCLA storage area.

Collecting samples from the drain valve is the preferred method, but this method will be conducted only if the drain valve is high enough from the ground to allow containment of any spilled material. Decontamination/drilling water containing solids will be transferred to C-752-C for on-site treatment of suspended solids, if necessary. Once the solids are removed (when required), the water will be characterized for treatment and disposal at the C-612 Northwest Plume Groundwater System. If the water otherwise meets discharge requirements for KPDES Outfall 001, including health-based levels for TCE and TCA and water quality criteria for TCE of 30.8 ppb, then the C-613 Sedimentation Basin may be used as the most appropriate on-site treatment for high total suspended solids removal before discharge. The water will be discharged through a KPDES outfall. One sample per portable water tank or drum will be collected for analysis when capacity is reached or fieldwork is complete. One duplicate sample will be obtained for every 20 samples collected.

8.3.4 Waste Water Treatment

Water from the decontamination of drilling equipment will be collected and stored as CERCLA waste. Following sampling and characterization to determine if the acceptance criteria are met, the water will be processed to remove suspended solids, if necessary, and then transported to either the C-400 IRA water treatment facility, C-612 Northwest Plume Groundwater System, or other acceptable facility for treatment to remove the hazardous constituent TCE. Following treatment, as necessary, to meet the effective effluent parameters in the KPDES permit, the wastewater will be discharged through KPDES Outfall 001.

9. QUALITY ASSURANCE PLAN

A QAPP for Phase IIA of the C-400 IRA, based on guidelines in *Uniform Federal Policy for Quality Assurance Project Plans*, is presented in Appendix B.

The governing QA documents for this IRA include, but are not limited to the QAPP, the *Quality Assurance Program and Implementation Plan for the Paducah Environmental Remediation Project*, PAD-PLA-QM-001 R2 (QAPIP) (DOE 2011b), and the CQCP (DOE 2008b).

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10. DATA MANAGEMENT AND IMPLEMENTATION PLAN

10.1 INTRODUCTION

The purpose of this DMIP is to identify and document data management requirements, applicable procedures, expected data types and information flow, and roles and responsibilities for data management activities associated with the C-400 IRA during remedial design, construction, and operation treatment system. Data management provides a system for efficiently generating and maintaining technically and legally defensible data that provide the basis for making sound decisions regarding environmental and waste characterization.

To meet current regulatory requirements for environmental management projects, complete documentation of the information flow must be established. Each phase of the environmental data management process (planning, collection, analysis, management, verification/validation, assessment, reporting, consolidation, and archival) must be appropriately planned and documented.

The scope of the DMIP is limited to environmental information collected during the design, construction, and operation of the IRA treatment system. This information includes electronic and/or hard copy records that describes environmental processes or conditions. Information generated by the project (e.g., analytical results from samples collected) and obtained from sources outside the project (e.g., historical data) falls 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 C-400 IRA is the reduction of the VOC source (TCE and breakdown products) in the subsurface at the C-400 Cleaning Building area through removal and treatment using ERH in both the UCRS and RGA. As part of the C-400 IRA, three distinct phases of sampling and analysis will occur: baseline, operational, and postoperational. Baseline sampling and analysis will establish the baseline concentration of VOCs in the subsurface by collecting soil and water samples, while installing the subsurface components of the system. Operational sampling and analysis will be used to measure progress and determine when remedial action goals have been met. Results from postoperational sampling and analysis will be compared to baseline results to calculate the percent reduction in VOC levels in the treatment area.

Specific activities involving data include, but are not limited to, collecting environmental and waste samples; storing, analyzing, and, if necessary, shipping samples; collection of operational and maintenance data; and evaluation, verification, validation, assessment, and reporting of analytical results.

10.2 DATA MANAGEMENT ACTIVITIES

Data management for the IRA will be implemented throughout the life cycle of environmental measurements and waste characterization data. This life cycle occurs from the planning of data, through the collection, review, use of the data for decision making purposes, and the long-term storage of data. The following sections contain a detailed description of these data management activities:

- Acquire existing data;
- Plan data collection;
- Prepare for field activities;

- Collect field data;
- Process field data;
- Collect field samples;
- Submit samples for analysis;
- Process laboratory analytical data;
- Review data;
- Verify data;
- Coordinate and perform data validation;
- Assess data;
- Consolidate, analyze, and use data and records; and
- Submit data to the 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 C-400 IRA will be downloaded from Paducah OREIS.

10.2.2 Plan Data Collection

Other documents in this RAWP provide additional information for the tasks of project environmental data collection, including the baseline/postoperational sampling plan, HASP, the QAPP, and the WMP. In addition, a laboratory SOW will be developed following approval of this work plan.

10.2.3 Prepare for Field Activities

The data management tasks involved in field preparation activities include identifying all sampling locations and preparing descriptions of these stations, developing summaries of all the samples and analyses to be conducted at each sampling location, developing field forms for capturing field data, coordinating sample shipment/delivery with off-site laboratories, and coordinating screening analyses with designated laboratories. The data management team will conduct these activities. The site superintendent and the data management team will coordinate data management activities with field sampling activities.

Before the start of field sampling, the data management team will specify and provide the contents of sample kits, which will include sample containers, labels, preservatives, chain-of-custody records, and any necessary sampling data forms. Samples will be collected according to contractor-approved procedures. Logbooks, sample labels, and chain-of-custody will be completed according to contractor-approved procedures. A comprehensive sampling list will be developed and used as the basis for finalizing the sample containers to

- Be used for sample collection;
- Order sufficient amount of containers and other supplies; and
- Verify the numbers of samples presented in the laboratory scope of work.

10.2.4 Collect Field Data

Field data will be collected, documented, and maintained according to the SAPs and contractor-approved procedures.

10.2.5 Process Field Data

Field measurements will be recorded on appropriate field forms or in field data compilers. These forms will be checked against the field logbooks, and the data will be manually entered into Paducah Environmental Measurements System (PEMS) using contractor-approved procedures.

10.2.6 Collect Field Samples

Personnel collecting samples for the project will record pertinent sampling information on the chain-of-custody, along with maintaining a field logbook. The data management team will manually enter information from the chain-of-custody forms and field forms into Paducah PEMS. Sampling locations will be surveyed using appropriate methods. Sample coordinates will be transferred to the PGDP coordinate system.

10.2.7 Submit Samples for Analysis

Before the start of field sampling, the data management team will coordinate the delivery of samples, and the receipt of results with the contract laboratories. The data management team will present a general sampling schedule to the off-site laboratories. The receipt of sample shipments and containers will be coordinated with the laboratories, and any requirements for laboratory permission to ship will be met. The data management team will ensure that hard-copy deliverables and electronic data deliverables (EDDs) from the laboratories contain the appropriate information and are in the correct formats.

10.2.8 Process Laboratory Analytical Data

Data packages and EDDs received from the laboratory will be tracked, reviewed, and maintained in a secure environment. Paducah PEMS will be used for tracking project-generated data from point of collection through final data reporting. The data management team is responsible for these tasks. The following information will be tracked, as applicable:

- Sample delivery group number;
- Date received;
- Number of samples;
- Sample analyses;
- Receipt of EDD, and;
- Comments.

The data management team will compare the contents of the data package with the chain-of-custody form and identify discrepancies. Discrepancies will be reported immediately to the laboratory and the sample/data coordinator. Copies of the Form I's from the data package will be distributed as necessary.

To evaluate the quality of laboratory EDDs, the first two EDDs from each laboratory will be 100% checked against the hard-copy data packages. After the first two EDDS from each laboratory are checked, every fifth EDD will be 100% checked. The results from the EDD will be checked, as will the format of all fields provided. The data management team will report immediately any discrepancies to the sample/data coordinator, so that the laboratory can be notified and EDDs can be corrected.

10.2.9 Review Data

The data management team will review the contents of the data package to ensure all necessary information is present and consistent with expectations.

10.2.10 Verify Data

The data management team is responsible for ensuring that data verification occurs as outlined in the procedure for quality assured data. Data verification processes for laboratory data will be implemented for both hard-copy data and EDDs. The data packages will be reviewed to ensure that all samples receive the analyses requested. Discrepancies will be reported to the laboratory. Electronic data verification of the EDDs will be performed as data are loaded into Paducah PEMS. The hard copy will be checked to ensure that requested parameters, indeed, were analyzed for; those missing from the EDD will be requested from the laboratory. Integrity checks in Paducah PEMS also will review the results generated by the laboratory to ensure that data for all requested parameters have been provided. Discrepancies will be reported to the sample/data coordinator. Additional information relating to Data Verification is included in the QAPIP.

10.2.11 Coordinate and Perform Data Validation

The data management team is responsible for coordinating data validation and for implementation of validation through the appropriate data validation procedures. Data validation will be performed on 100% of the selected data packages. Validation will be performed on a minimum of 10% of the environmental data collected. Validators not associated with the project will perform validation following contractor-approved procedures. Additional information relating to data validation is included in the QAPIP. A validation SOW is generated specifying the requirements for the validation of the data. Validation problems must be identified and appropriately resolved. Qualifiers and reason codes may be assigned to the data to indicate usability concerns. Validation qualifiers are input and stored in Paducah PEMS and transferred with the data to Paducah OREIS.

10.2.12 Assess Data

Data assessment will be conducted and documented by a technical reviewer in conjunction with other project team members, according to the contractor-approved procedure for quality assured data. Data assessment follows data verification and data validation (if applicable) and must be performed at a rate of 100% to ensure data are useable. The data review process determines whether a set of data satisfies the data requirements defined in the project-scoping phase and assures that the type, quality, and quantity of data are appropriate for their intended use. It allows for the determination that a decision (or estimate) can be made with the desired level of confidence, given the quality of the data set. This process involves the integration and evaluation of all information associated with a result.

Data review consists of an evaluation of the following: data authenticity, data integrity, data usability, outliers, and PARCCS parameters. Additional requirements for data assessment and review are included in the QAPIP. Assessment qualifiers are stored in Paducah PEMS and transferred with the data to Paducah OREIS. Data are made available for reporting upon completion of the data assessment, and associated documentation is stored with the project files.

10.2.13 Consolidate, Analyze, and Use Data and Records

The data consolidation process consists of the activities necessary to prepare the evaluated data for the users. The project team will evaluate the field and analytical data from the environmental and waste samples in support of operational decision making and to characterize the project waste before disposal. The data will be stored in the Paducah OREIS database for future use.

Project reports are generated for the purpose of evaluating the data for the project. These reports include the status of the sampling event, reports of data compared to various criteria, and reports of the complete set of data. Data analysis will be documented in sufficient detail to allow re-creation of the analysis.

Project reports may be generated from PEMS. Official data reporting for reports to outside agencies will be generated from data stored in Paducah OREIS, as applicable.

10.2.14 Submit Data to the Paducah OREIS

Upon completion of the data assessment, verification, and validation, the data will be transferred from Paducah PEMS to Paducah OREIS. The data management team is responsible for transferring the data to Paducah OREIS.

10.3 DATA MANAGEMENT INTERACTIONS

The sample/data management manager oversees the use of Paducah PEMS and ensures that data deliverables meet project requirements. The data management team will enter information related to the fixed-base laboratory data packages and the tracking associated with the samples once the samples have been shipped and the receipt of the samples has been verified. The data management team will load the fixed-base laboratory hard-copy data, the EDDs, and the field measurement data into Paducah PEMS. The data management team is responsible for transferring the data from the Ready to Load (RTL) files to the Paducah OREIS database.

The sample/data coordinator will develop the SOW to be performed by an approved analytical laboratory that has been audited under DOECAP. Analytical methods, laboratory QC requirements, and deliverable requirements will be specified in this SOW. The data management team will receive EDDs, perform contractual screenings, and distribute data packages. The data management team will interface with the contract laboratory to ensure that hard copy and electronic deliverable formats are properly specified and 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 Historical Data

Historical data consist primarily of analytical data. Existing and historical data will be evaluated prior to field activities (e.g., sampling, field measurements). Paducah OREIS and the Paducah OREIS Data Catalog will be queried as necessary for existing information relating to the project. Historical data downloaded from Paducah OREIS will be available in Paducah PEMS for project team use for the duration of the project.

10.4.3 Field Measurements

Field measurements that may be collected include field measurements of environmental and waste samples and global positioning system readings for each sample location. Field measurements may be recorded on appropriate data log sheets. The data management team will enter the data from these sheets, manually, into Paducah PEMS. A QC check of this data entry, which involves comparing printouts of the data in the project Paducah PEMS to the original field logbook or data log sheet, will be made.

10.4.4 Analytical Data

Analytical data that will be collected includes volatile, semivolatile, and radionuclides from soil and groundwater samples. Paducah PEMS will be used to plan, track, and manage the collection of all analytical data. The tracking system for the project will include field logbooks, field forms, chain-of-custody records, and hard-copy data packages, as well as EDDs. Following completion of the appropriate data verification, validation, and assessment activities, the final data set will be uploaded from Paducah PEMS to Paducah OREIS.

10.5 GEOGRAPHIC INFORMATION SYSTEM DATA

The Paducah GIS network will be used to prepare maps to be used in data analysis of both historical and newly generated data and reporting. Coverage anticipated for use during the project is as follows:

- Stations (station coordinates will be downloaded from Paducah OREIS)
- Facilities
- Plant roads
- Plant fences
- Streams
- Topographic contours (as available from the 1990 flyover)

10.6 DATA FORMS/LOGBOOKS

Field logbooks, site logbooks, diskette logs, chain-of-custody forms, data packages with associated QA/QC information, and field forms are maintained according to the requirements defined in procedure PAD-RM-1009, *Records Management, Administrative Records, and Document Control*.

Duplicates of field records will be maintained until the completion of the project according to contractor-approved procedures. Logbooks and field documentation will be copied periodically. The originals will be forwarded to the project files; the copies will be maintained in a separate location. The project file will be considered the record copy and, as such, will be stored in accordance with contractor-approved procedures.

Electronic versions also will be stored in the project file; the originator or the original recipient of the diskette will maintain backup copies.

10.6.1 Field Forms

Sample information is environmental data describing the sampling event and consists of the following: station (or location), date collected, time collected, and other sampling conditions. This information is recorded in field forms, such as logbooks, chain-of-custody forms, or sample labels. This information is entered directly into Paducah PEMS by the data entry specialist. Field chain-of-custody forms contain sample-specific information recorded during collection of the sample. This information is entered directly into Paducah PEMS by the data management team. The SAP provides detailed information on sampling locations, types of samples, sample parameters required at each location, and the frequency of collection for samples. Any deviations from the sampling plan will be noted on the field chain-of-custody form. The sampler will review each field chain-of-custody form for accuracy and completeness, as soon as practical, following sample collection.

Chain-of-custody forms will be generated from Paducah PEMS with the following information:

- **Information that is preprinted**
  - Chain-of-custody number
  - Project name or number
  - Sample ID number
  - Sampling location (e.g., 001-001)
  - Sample type (e.g., REG = regular sample)
  - Sample matrix (e.g., SO = soil)
  - Sample preservation type
  - Analysis (e.g., Tc-99)
  - Sample container (volume, type)
  - Preservative

- **Information that is entered manually**
  - Sample date and time
  - Top and bottom depths and units
  - Sample comments (optional)

Sample identification numbers are identified in Paducah PEMS, assigned by the sample/data management manager, and uniquely identify each sample. Sample labels shall contain sufficient information to identify the sample in the absence of other documentation. The label shall be affixed to the sample container; shall be completed with black, indelible ink; and shall include the following, at a minimum:

- Project number
- Unique sample number
- Sample location
- Sample media
- Analysis to be performed
- Sampling date and time
- Organization collecting the sample
- Preservation method

An example of the sample identification scheme is as follows:

C400nnnM000

where:

C400	Identifies facility
nnn	Identifies the sequential boring number
M	Identifies the media type (W identifies the sample as groundwater, S identifies the sample as soil)
000	Identifies the planned depth of the sample in ft bgs

10.7 DATA AND DATA RECORDS TRANSMITTALS

10.7.1 Paducah OREIS Data Transmittals

All data (measurements and geographic) contained in reports submitted to state and federal regulators are required by the FFA to be transferred to OREIS before or on the date of the report submission. Official data reporting, contained in other reports to outside agencies, will be generated from data stored in Paducah OREIS for any applicable data stored there. The data management team will submit data to be stored in Paducah OREIS prior to reporting.

10.7.2 Data Records Transmittals

Upon completion of the project, the original logbooks, field documentation, and project deliverables will be forwarded to the PGDP Document Management Center according to contractor-approved procedures.

10.8 DATA MANAGEMENT SYSTEMS

10.8.1 Paducah PEMS

Paducah PEMS is the data management system that supports the project's sampling and measurements collection activities, and the generation of Paducah OREIS RTL files. Appropriate project staff can access Paducah PEMS throughout the life cycle of the project. Paducah PEMS will be used for the following functions:

- Initiate the project,
- Plan for sampling,
- Record sample collection and field measurements,
- Record sample shipment information,
- Receive and process analytical results,
- Evaluate and verify data,
- Analyze and access data,
- Transfer project data (in RTL format) to Paducah OREIS, and
- Store non-Paducah OREIS data.

Paducah PEMS is used to generate sample chain-of-custody 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 Paducah PEMS include backups and security.

The information technology group performs system backups daily. The security precautions and procedures implemented by the sample and data management organization are designed to minimize the vulnerability of the data to unauthorized access or corruption. Only users approved by the sample and data management organization have access to the project's Paducah PEMS and the hard-copy data files. Users have installed password-protected screen savers.

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 environmental management projects. Paducah OREIS is comprised of hardware, commercial software, customized integration software, an environmental measurements database, a geographic database, and associated documentation. Paducah OREIS will be used for the following functions:

- Access to existing data,
- Access to project data,
- Report generation,
- Long-term storage of project data (as applicable), and
- Submit data to regulators.

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 all environmental projects within the Paducah Site. The Paducah Analytical Project Tracking System supplements the SMO tracker in cradle-to-grave tracking of sampling and analysis activities. 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 Paducah PEMS (output from the Paducah Analytical Project Tracking System automatically goes to Paducah PEMS).

10.9 DATA MANAGEMENT TASKS AND ROLES AND RESPONSIBILITIES

10.9.1 Data Management Tasks

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.

10.9.2 Data Management Roles and Responsibilities

The following project roles are defined, and the responsibilities are summarized for each data management task described in the previous subsection.

10.9.2.1 C-400 PM

The C-400 PM is responsible for the day-to-day operation of the project. The C-400 PM ensures the requirements of policies and procedures are met. The C-400 PM or designee assesses data in accordance with PAD-ENM-5003, *Quality Assured Data*. The C-400 PM is responsible to flowdown data management requirements to subcontractors as required.

10.9.2.2 Project team

The project team consists of the technical staff and support staff (including the data management team) that conducts the various tasks required to successfully complete the project.

10.9.2.3 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.

10.9.2.4 Data entry specialist

The data entry specialist 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 data entry specialist loads the EDD to Paducah PEMS, performs electronic verification of the data, and then compiles the data assessment package. The data entry specialist also may prepare data for transfer from Paducah PEMS to Paducah OREIS.

10.9.2.5 Project records coordinator

The project records coordinator is responsible for the long-term storage of project records. The C-400 project team will interface with the project records coordinator and will transfer documents and records in accordance with DOE requirements.

10.9.2.6 QA specialist

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

10.9.2.7 Sample/data management manager

The sample/data management 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 sample/data management manager ensures compliance with procedures relating to data management with respect to the project and that the requirements of PAD-ENM-5003, *Quality Assured Data,* are followed.

10.9.2.8 Laboratory coordinator

The sample/data coordinator is responsible for contracting any fixed-base laboratory utilized during the sampling activities. The sample/data coordinator also provides coordination for sample shipment to the laboratory, contractual screening of data packages, and transmittal of data packages to the Document Management Center.

11. ENVIRONMENTAL COMPLIANCE

11.1 INTRODUCTION

Environmental regulatory compliance will be facilitated during the implementation of the C-400 IRA by adhering to ARARs that have been identified throughout the project planning, scoping and decision making process. The CERCLA Act of 1980, as amended, requires, in part, that remedial actions for cleanup of hazardous substances comply with promulgated requirements and/or standards under federal or more stringent state environmental laws and regulations. These requirements are identified as those being specific to the hazardous substances or particular circumstances at a site and must be complied with, or be waived, as part of a total remedial action, under the CERCLA decision making process [40 *CFR* § 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker radiation protection requirements. Per 40 *CFR* § 300.405(g)(3), nonpromulgated advisories, criteria, or guidance, known as to be considered (TBC), may be considered in determining remedies. Because this IRA will be conducted in accordance with Section XXI of the FFA for the PGDP and Section 121(e)(1) of CERCLA, on-site activities are exempted from procedural requirements to obtain federal, state, and local permits.

ERH will result in reducing the source of TCE and other VOC contaminants reaching groundwater. On completion of the ERH source reduction, a continued decrease in concentrations of TCE and other VOCs is expected. Because the GWOU contamination is extensive, multiple actions are planned to provide overall remediation of the groundwater. ERH is one of the IRAs to be taken to provide overall remediation of groundwater and its sources of contamination.

Other environmental contamination at PGDP not related to this remedial action is to be addressed in separate decision documents (i.e., ROD); however, those decisions will be supported by this interim remedial action.

A brief summary of the ARARs/TBCs associated with the interim remedial action 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. The specific requirements associated with ERH are discussed further below.

11.2.1 National Primary Drinking Water Standards

The National Primary Drinking Water Standards include maximum contaminant limits (MCLs) for several of the contaminants found within groundwater at PGDP and are considered relevant and appropriate requirements for potable groundwater. While ERH is not expected to result in attainment of the MCL for TCE and its degradation products (*trans*-1,2-DCE, *cis*-1,2-DCE, vinyl chloride, and 1,1-DCE) at the time treatment ceases, it satisfies the requirements in 40 *CFR* § 300.430(f)(1)(ii) for interim actions to meet ARARs. Under the National Contingency Plan (NCP) at 40 *CFR* § 300.340(f)(1)(ii)(C)(1), an alternative that does not meet an ARAR may be selected when the alternative is an interim measure and the ARAR will be attained or waived as part of a total remedial action.

11.2.2 Kentucky Surface Water Standards

Kentucky Surface Water Standards are included as ARARs for this interim remedial action because treated groundwater will be discharged to surface water bodies after treatment. The substantive requirements include discharge limits of KPDES permit KY0004049.

11.3 LOCATION-SPECIFIC ARARs/TBC

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 lists the federal and state location-specific ARARs for protection of sensitive resources.

11.3.1 Protection of Wetlands

Installation of treatment systems may impact nondelineated wetlands during the construction phase of remedy implementation. As required at 10 *CFR* § 1022, 40 *CFR* § 230.10, and 33 *CFR* § 330.5, all activities will be designed to avoid or minimize impacts to wetlands identified within the area of deployment of the remedy. The use of best management practices (BMPs) and proper siting of equipment and construction areas will be considered and conducted, as necessary, to comply with these substantive requirements.

11.3.2 Endangered Species Act

Installation activities must not impact or jeopardize the existence of a listed species or result in the destruction or impact to critical habitat. These requirements are specified at 16 U.S.C. 1531 Section 7(a)(2). Possible existence of endangered species or species habitat must be considered within the area of deployment of the remedy. This ARAR shall be achieved by avoiding such areas.

11.3.3 Migratory Bird Treaty Act

The requirements of the Migratory Bird Treaty Act require that similar measures are taken with regard to protected migratory species. As with endangered species, these substantive requirements will be complied with through assessment of the area of deployment to ensure no adverse impact occurs.

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. Component actions include groundwater extraction, treatment, and monitoring; waste management; and transportation. ARARs/TBCs for each component action are listed in Section 11.5. The substantive requirements of applicable requirements are described below.

11.4.1 Fugitive Dust Emissions

Substantive requirements for the control of fugitive dust and storm water runoff potentially provide ARARs for all construction and site preparation activities. Reasonable precautions must be taken, including the use of BMPs for erosion control to prevent runoff and application of water on exposed soil/debris surfaces to prevent particulate matter from becoming airborne. 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). Chemical-specific ARARs for these actions include radiation emission requirements for the public and control of potential fugitive emissions of TCE and other VOCs, as applicable.

General surface activities have the potential to create dust. These surface dust emissions will be minimized by covering all ground surfaces with concrete, asphalt, or gravel. If dust is observed, a water spray will be used to control the observed dust. No particulate emissions are anticipated for the below grade activities.

11.4.2 Toxic Emissions

C-400 potential hazardous air pollutants (HAPs) have been identified based on characterization of the groundwater as documented in *Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2211&D2 (DOE 2005b). The potential HAPs identified are TCE, vinyl chloride, *trans*-1,2-DCE, *cis*-1,2-DCE, and 1,1-DCE. These HAPs will be removed from the subsurface using ERH. ERH involves *in situ* heating of soils resulting in the collection and recovery of contaminants from the aquifer and vadose zone. The treated vapor/gases must comply with the contaminant concentration requirements of 401 *KAR* 63:020. An off-gas treatment system shall be employed to ensure contaminant emissions do not exceed allowable levels. This system may include such equipment as condensers and/or filters to accomplish the required contaminant removal.

In accordance with 401 *KAR* 63:020, the concentration of each of the HAPs that is released must be not be more than a value calculated that would be protective of human health and the environment. This is accomplished by ensuring that HAPs concentrations at the property boundary of the facility are less than the values required under 401 *KAR* 63:020. The required air concentrations were calculated using values in the EPA Toxics Table, Prioritized Chronic Dose-Response Values for Screening Risk Assessments at http://www.epa.gov/ttn/atw/toxsource/table1.pdf and may have their basis in either Region 9 Preliminary Remediation Goals (PRGs) values at http://www.epa.gov/region09/waste/sfund/prg or Integrated Risk Information System values. Allowable concentrations then were calculated using the methods outlined in EPA's *Air Toxics Risk Assessment Reference Library, Volume 2, Facility Specific Assessment*. These values are based on the cancer and non-cancer risks posed by long-term exposure to HAPs. The chemicals that are a cancer risk have an associated concentration that will result in a receptor at the property boundary having an increase of less than one in one million (1×10^{-6}) of getting cancer from exposure to a carcinogen over a 70-year time period. The health effects of exposure to chemicals that are a non-cancer risk are measured by a hazardous index; with a hazard index of 1 being an indication of a boundary-located receptor having detrimental health effects from exposure to that chemical. The C-400 IRA HAPs are both carcinogenic and noncarcinogenic, with the greater of the two risks for each chemical as follows:

- Noncancer—1,1-DCE, *trans*-1,2-DCE, *cis*-1,2-DCE
- Cancer—vinyl chloride, TCE.

11.4.3 Emissions Estimate

This section summarizes the air dispersion analysis of potential hazardous air pollutant emissions from the implementation of the C-400 IRA. The property boundary concentrations for these potential hazardous air pollutant emissions were estimated utilizing using BREEZE AERMOD GIS Pro v5.1.7.

Appendix C contains a more detailed discussion of this analysis as well as an electronic copy of output reports and model-ready input files.

11.4.3.1 Construction Fugitive Emissions

During construction of the ERH, fugitive emissions will be released. The fugitive emissions occur when the subsurface equipment such as electrodes and well completion components are placed in the boreholes and displace the contaminate-laden air. The amount released is estimated to be 2.5 lb of all HAPs over five months. The off-site limit, estimated fugitive emission rate, and resulting maximum off-site concentration for each HAP, is shown in Table 13.

Table 13. Estimated Off-site Concentrations for Fugitive Emissions

Chemical	Off-site limit	Fugitive Emission Rate	Annual Average Maximum Off-site Concentration
	μg/m³	g/s	μg/m³
TCE	0.5	7.23E-6	1.1E-5
vinyl chloride	0.11	8.6E-7	1.3E-6
trans-1,2-dichloroethene	73	7.9E-6	1.2E-5
cis-1,2-dichloroethene	37	1.5E-6	2.3E-6
1,1-dichloroethene	210	1.0E-6	1.5E-6

The estimated air concentration for each hazardous air pollutant is less than the off-site limit. This demonstrates compliance of the design with 401 *KAR* 63:020.

11.4.3.2 Operations Emissions

During operation of the project, the hazardous constituents in the subsurface will be volatilized underground and recovered by a vapor phase extraction system. The system will capture the soil vapors, which will be treated and released through a stack. The current design utilizes activated carbon filtration to remove hazardous constituents from the off-gas with a second activated carbon filtration unit to polish the treatment prior to discharge to the atmosphere. The current design criteria for the treatment system is such that the concentrations of an individual HAP in the exhaust stack will not exceed 20 ppmv. Analyzer results will be recorded in approximately two minute intervals during operation. The sampling frequency may be evaluated after initial operation to determine if a longer duration for sampling would adequately record data and may be adjusted with the concurrence of EPA and KDEP. Calibration/functional checks will be performed in accordance with manufacturer specifications.

The property boundary ambient concentration for each HAP was estimated utilizing the air dispersion model BREEZE AERMOD GIS Pro v5.1.7. The exhaust was assumed to contain the maximum concentration of each HAP. The preliminary design parameters[8] for the stack were used in the model, which are as follows:

[8] The last paragraph of Section 4.5.3 in the RDR states, "Off-gas from the vapor-phase polishing system will be discharged to the atmosphere through a 20-ft tall by 8 inch diameter stack."

- 8-inch diameter
- 20-ft high
- 300 to 2,300 scfm flow rate
- 70°F exhaust gas temperature

The meteorological data from 2003 were used in the model because it will result in higher off-site concentrations than any other of the past 5 years of valid meteorological data. Because the project is adjacent to C-400 Building, building wake effects are included in the analysis.

The annual average maximum off-site concentration estimated by the air dispersion model is listed for each pollutant in Table 14.

Table 14. Estimated Off-site Concentrations for Emission Stack Design Concentrations

Chemical	Off-site limit	Annual Average Maximum Off-site Concentration		
		300 scfm	1,800 scfm	2,300 scfm
	μg/m³	μg/m³	μg/m³	μg/m³
TCE	0.5	0.0117	0.0555	0.0677
vinyl chloride	0.11	0.00557	0.0264	0.0322
1,1-DCE	210	0.00864	0.0410	0.0500
cis-1,2-DCE	37	0.00864	0.0410	0.0500
trans-1,2-DCE	73	0.00864	0.0410	0.0500

Table 14 has been revised since the Phase I RAWP. Experience from Phase I has shown that the flow rate of the stack exhaust is based on the system vacuum blower speed. The blower speed varies as necessary to achieve the desired vacuum level at the well field. An additional effluent stream from drying and cooling the regenerated granular activated carbon also flows through the stack. This additional flow rate can vary from 300 to 1,000 scfm. The total flow rate through the stack can vary from 300 scfm during emergency operations to a maximum of 2,300 scfm during peak operations. The design flow rate is 1,800 scfm; therefore, three different off-site concentration values are shown for each chemical as compared to the discharge flow rate.

The maximum off-site concentration for each hazardous air pollutant is less than the off-site limit listed in Table 14, demonstrating compliance of the design with 401 *KAR* 63:020.

Off-gas emissions from the treatment system will be monitored by a photoacoustic analyzer. The analyzer will communicate with a control system to shut down the vapor extraction and treatment system and notify operations personnel in the event of an exceedance of discharge criteria.

11.4.4 Subsurface ERH Components

Subsurface ERH components will consist of electrodes, vapor/groundwater extraction wells, and temperature/pressure monitoring equipment. These components will be installed in boreholes created using traditional drilling techniques. The subsurface equipment will be installed to minimize the potential for the introduction of pollutants into the subsurface during construction and operations.

A portion of the groundwater extracted during operations will be reintroduced to the heated volume at the electrodes after treatment to maintain moisture levels. Section 11.4.10 provides more detail with regard to groundwater injection at the electrodes. The remainder of the treated water will be discharged and will meet KPDES-permitted Outfall 001 discharge criteria.

The multiphase extraction (MPE)-dual well borings, extraction well borings, and contingency well borings will be abandoned by extracting the casing and grouting to the surface as required for MWs by 401 *KAR* 6:310 (6).

Although removal of other subsurface system elements such as the vapor extraction wells, temperature monitoring borings, and pressure monitoring borings is not required by regulation, an attempt to abandon these components will be made by the following methods. All of these borings, except for the groundwater sampling/extraction wells listed above, will have high temperature cement grout installed to a minimum depth of 5.0 ft bgs. This is intended to minimize the potential of infiltration of surface waters along the borehole. The vacuum monitoring well borings, DigiTAM sensor well borings, and dual sensor well borings will have the sensors removed and the 2-inch fiberglass pipe perforated and then filled with grout to the surface.

Electrode borings will be abandoned as outlined in Section 11.4.10.

11.4.5 Discharge of Storm Water and Treated Groundwater

Management of aqueous wastes will include procedures to minimize the possibility of spills and releases to the environment. Berms and dikes will be constructed to minimize contact of waste with surface water run-on and run-off. Where precipitation accumulates in the diked areas that hold contaminated wastes, it will be managed as contaminated until analyses show otherwise. It will be treated, as needed, to meet the KPDES-permitted Outfall 001 discharge limits prior to discharge.

Contaminated water, including decontamination fluid, collected storm water, groundwater, and condensate from the off-gas treatment system, will be treated as need to meet discharge limits. Where these waters meet the acceptance criteria for on-site treatment facilities at the PGDP, treatment is expected to occur on-site with discharge through KPDES-permitted Outfall 001. Where these waters do not meet on-site acceptance criteria or result in exceedances of on-site treatment capacity, they will be shipped to an appropriate off-site wastewater treatment facility for treatment and subsequent discharge. Shipment to any off-site facility shall be conducted in accordance with the applicable requirements of 40 *CFR* § 300.440 *et seq.* (CERCLA Off-site Rule).

11.4.6 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 appropriately characterized as RCRA wastes (solid or hazardous); PCB waste; radioactive waste(s); and/or mixed waste(s), as appropriate, and, respectively, be managed in accordance with appropriate RCRA, Toxic Substances Control Act (TSCA), or DOE Order/Manual requirements. Wastes managed on-site must comply with the substantive requirements of the aforementioned ARARs. 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 0.030 ppm TCE in aqueous wastes generated by this interim remedial action. The WMP, as part of this RAWP, is subject to regulator review and approval under the procedures outlined in the FFA. The analytical results will be compared against the contained-in, health-based levels listed above, and a determination made. LDRs apply to media and debris that no longer contain or are no longer contaminated with RCRA regulated waste.

11.4.7 PCB Waste Management

One of the substantive requirements of TSCA is that wastes that have concentrations of PCBs greater than ≥ 50 ppm must be managed in accordance with 40 *CFR* § 761. These requirements include labeling, characterization, manifesting, and disposal in a facility that is designed for and permitted to receive PCB-contaminated wastes.

11.4.8 National Emission Standards for Hazardous Air Pollutants

EPA regulations also include limitations on the radiological dose allowed to members of the public in the NESHAP regulations in 40 *CFR* § 61 (and 401 *KAR* 57:002, which incorporates the federal regulations by reference). 40 *CFR* § 61.92 establishes 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.

The system design capacity for groundwater extraction is approximately 80 gal per minute (303 L per minute). This would result in extraction of approximately 159,278,000 L of water during the estimated 12 months of system operation, if operated continuously. The highest Tc-99 concentration detected in the groundwater in the area during the Six-Phase Treatability Study was 160 pCi/L. The annual amount of Tc-99 released using these conservative assumptions are calculated as follows:

$[(159{,}278{,}000 \text{ L/year}) \times (160 \text{ pCi/L})] \times (1 \text{ Ci}/10^{12}\text{pCi}) = 0.0255 \text{ Ci/year}$

The ERH process could heat the Tc-99 above 100ºC; therefore, in accordance with 40 *CFR* § 61Appendix D, it is assumed the Tc-99 becomes a gas and that it will all be emitted from the stack.

The following stack parameters are used to estimate resultant dose:

- 20-ft tall stack
- 8-inch diameter stack
- 1,500 scfm flow rate
- 70ºF stack temperature

These parameters, in addition to the Tc-99 value calculated above, were used in the CAP88-PC Version 2.00 program to estimate the potential dose to the maximum exposed individual. The resulting dose would be approximately 7.6×10^{-3} mrem/yr, well below the threshold requiring regulatory permission to construct.

Using the stack parameters above, an influent Tc-99 concentration of 2,075 pCi/L would be required to result in a dose approaching the regulatory threshold. The treatment system influent will be sampled weekly for Tc-99 and, if the level is observed to be 1,500 pCi/L or above, the potential dose will be reevaluated.

This limit should not be exceeded, because as the system operates, water will be extracted from the treatment zone. The groundwater will be treated using an ion exchange resin to remove Tc-99. A portion of this treated water will be returned to the treatment zone. Dose calculations herein are based on an assumption of constant Tc-99 concentrations in extracted groundwater. Actual conditions are expected to be a reduction in Tc-99 concentrations over time due to the reinjection of treated groundwater.

11.4.9 Transportation

Any remediation wastes transferred off-site 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 fully complied with 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 *et seq.*).

11.4.10 Underground Injection Control

The project design for the remedial action requires that treated groundwater be injected into the subsurface to enhance heating of the area surrounding the electrodes. The injection of fluids is necessary because the water in the formation immediately surrounding the boreholes evaporates as the formation is heated, reducing the ability of the formation to conduct heat, thereby reducing the effectiveness of ERH. To prevent these conditions, groundwater extracted as part of the remediation process will undergo initial treatment and then be reinjected into the subsurface treatment zone to maintain moisture around the electrodes, thereby providing favorable conditions for conductivity and heat transfer, as well as serving to cool the electrodes and prevent burnout. Prior to reinjection, the contaminated groundwater will undergo treatment to significantly reduce contaminant concentrations, but the reinjected groundwater still will contain TCE at elevated levels. These specific design parameters, which pertain to reinjection of groundwater, were developed as part of the post-ROD design phase, but do not constitute a change in the scope, performance, or cost of the selected remedy.

Injection of fluids into groundwater may trigger 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), states that no owner or operator shall construct, operate, maintain, covert, plug, abandon, or conduct any other injection activity in a manner 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 under 40 *CFR* part 142 or may otherwise adversely affect the health of persons; and (2) 40 *CFR* § 144.23(b)(1), pertains to closure of Class IV injection wells.

While treated TCE contaminated groundwater will be intermittently reinjected during operation of the ERH system, such reinjection is expected to beneficially contribute to the efficiency of the operation and result in an overall reduction in TCE concentrations in treated zones upon completion of the action. The area affected by the reinjection is expected to be limited to the immediate area within the treatment zone as a result of hydraulic control measures that will be implemented during operation to reduce contaminant migration. The design of this remedy is intended to meet the substantive requirements of 40 *CFR* § 144.12(a). The wells are constructed to maintain control of injected material to prevent movement of fluid containing any contaminant into underground sources of drinking water. Injected water is treated beforehand to remove TCE and Tc-99. The RAWP will be approved by the EPA and Commonwealth of Kentucky, which qualifies for an exemption under 40 *CFR* § 144.13(c) to reinject groundwater. The plugging and abandonment method that will be used to meet the substantive requirements for closure under 40 *CFR* § 144.23(b)(1) is as follows. During installation, all of the electrode borings will have high temperature cement grout installed to a minimum depth of 5.0 ft bgs. This is intended to minimize the potential of infiltration of surface waters along the borehole. Electrode borings that contain screened intervals will have the 2-inch fiberglass pipe perforated down to the screened interval and then filled with grout to the surface. All electrode borings will have grout pumped through the water injection lines into the electrodes that are 53.15 ft bgs and above (53.15 ft bgs is the depth of the electrode nearest the UCRS/RGA interface, which is at approximately 55 ft bgs).

Contained in 40 *CFR* § 144.13 is a prohibition for construction, operation, or maintenance of Class IV wells except in cases where the reinjection of contaminated groundwater has undergone prior treatment, is being reinjected into the same formation from which it was drawn, and such injection is approved by EPA or a state, pursuant to provisions for cleanup of releases under CERCLA or RCRA. The reinjection of the TCE-contaminated groundwater associated with the C-400 action meets the exception criteria outlined in 40 *CFR* § 144.13(c) and RCRA § 3020(b) and, therefore, is not prohibited by regulation or statute.

11.4.11 Summary of ARARs for Primary Source Area

Tables 15 through 17 list the chemical-specific, location-specific, and action-specific ARARs/TBCs for the IRAs in the selected remedy.

Table 15. Summary of Chemical-Specific ARARs for Primary Source Area—Electrical Resistance Heating

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
National Primary Drinking Water Standards	40 *CFR* § 141	Provides chemical-specific numeric standards for toxic pollutants expressed as MCLs and MCLGs.	The substantive requirements are relevant and appropriate due to the nature of the contaminants found within the groundwater. The substantive requirements will be met to the extent practicable for an interim action. While ERH is not expected to result in attainment of the MCL for TCE and its degradation products (*trans*-1,2-DCE, *cis*-1,2-DCE, vinyl chloride, and 1,1-DCE) at the time treatment ceases, it satisfies the requirements in 40 *CFR* § 300.430(f)(1)(ii) for interim actions to meet ARARs. Under the National Contingency Plan (NCP) at 40 *CFR* § 300.340(f)(1)(ii)(C)(1), an alternative that does not meet an ARAR may be selected when the alternative is an interim measure and the ARAR will be attained or waived as part of a total remedial action.

BACK

TABLE OF CONTENTS

FORWARD

Table 15. Summary of Chemical-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Kentucky Surface Water Standards	401 *KAR* 5:031 and 5:026	Provides chemical-specific numeric standards for discharge of pollutants in domestic water supplies. Provides chemical-specific numeric standards for pollutants discharged or found in surface waters.	The substantive standards are ARAR to the segment of the Ohio River (domestic water supply) into which the Little Bayou Creek discharges. The substantive requirements found in these standards are ARAR due to the discharges at seeps in to Little Bayou Creek (outside of the current KPDES outfalls), which subsequently discharges to the Ohio River. The ERH action will reduce VOCs in the groundwater at the C-400 area, which is contributing to downgradient TCE contamination at the seeps. While the ERH action is not expected to attain Kentucky Surface Water Standards at the seeps, these standards will be met or waived by subsequent remedial actions under other operable units, including, but not limited to, the surface water operable unit and the groundwater dissolved-phase plume operable unit. See 40 *CFR* § 300.430(f)(1)(ii) (C)(1). Note: Clean Water Act Water Quality Criteria are not ARAR because Kentucky has promulgated state standards determined to be appropriate for Kentucky waters.
Radiation Exposure of the General Public at DOE Facilities	*DOE Order 5400.5*	*Specifies that the public must not receive an effective dose equivalent of > 100 mrem/year from all exposure pathways. In addition, all releases of radioactive materials resulting in doses to the public must meet the ALARA criteria.*	*The substantive requirement is TBC information.*
Decommissioning Standards at Nuclear Facilities	*10 CFR § 20, Subpart E*	*Specifies a residual activity at nuclear facilities for unrestricted release of 25 mrem/year.*	*The substantive requirements are considered to be relevant and appropriate because radionuclides are found in groundwater in the C-400 Cleaning Building area.*

Table 16. Summary of Location-Specific ARARs for Primary Source Area—Electrical Resistance Heating

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Protection of Wetlands	10 *CFR* § 1022; Executive Order 11990; 40 *CFR* § 230.10; 33 *CFR* § 330.5	Activities must avoid or minimize impacts to wetlands to preserve and enhance their natural and beneficial value. If wetland resources are not avoided, measures must be taken to address ecologically sensitive areas and mitigate adverse effects. Such measures may include minimum grading requirements, runoff controls, design, and construction considerations. Allows minor discharges of dredge and fill material or other minor activities for which there is no practicable alternative, provided that the substantive requirements of the Nationwide Permit system are met.	The substantive requirements of the regulations are ARAR due to the presence of wetlands and will be met through avoidance of wetlands during construction and implementation of alternatives. Discharges of dredge and fill material will not be necessary in this interim action.
Endangered Species Act	16 U.S.C. 1531 *et seq*. § 7(a)(2)	Actions that jeopardize the existence of listed species or result in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	The substantive requirements are ARAR because habitat for threatened and endangered species is present near the PGDP outside the industrialized area. They will be met through avoidance of critical habitat because the construction of this interim action is within the industrial section of the plant.

Table 16. Summary of Location-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Migratory Bird Treaty Act	16 U.S.C. 703-711; Executive Order 13186	Federal agencies are encouraged (until requirements are established under a formal Memorandum of Understanding) to do the following: • Avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions; • Restore and enhance the habitats of migratory birds, as practicable; • Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable; • Ensure that environmental analysis of federal actions required by the National Environmental Policy Act or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern; and • Identify where unintentional uptake likely will result from agency actions and develop standards and/or practices to minimize such unintentional take.	The substantive requirements are ARAR because migratory birds frequent the PGDP. The requirements will be met by avoiding habitat and controlling airborne releases of contaminated media. Due to the highly industrialized nature of the C-400 Cleaning Building area, no migratory bird habitat will be disturbed.

Table 17. Summary of Action-Specific ARARs for Primary Source Area—Electrical Resistance Heating

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Fugitive Dust Emissions during site preparation and construction activities.	401 *KAR* 63:010	Precautions must be taken to control particulate matter from becoming airborne. Such precautions must be incorporated into the planning and design of activities and include actions such as these: • Wetting or adding chemicals to control dust from construction activities; • Using materials such as asphalt or concrete (or other suitable chemicals/fixing agents) on roads or material stockpiles to prevent fugitive emissions; and • Using covers on trucks when transporting materials to and from the construction site(s). This requirement specifies that, for on-site construction activities, no visible emissions may occur at the PGDP fence line.	The substantive requirements are applicable and will be met through the use of appropriate dust control practices such as water spraying.
Toxic Emissions	401 *KAR* 63:020 and 401 *KAR* 63:002	401 *KAR* 63:020 requires that no emissions are allowed that are harmful to the health and welfare of humans, animals, and plants.	The substantive requirements of these regulations are considered to be applicable. Consistent with CERCLA Section 121(e)(1), no Title V Air Permit will be required for the production of toxic emissions. Dispersion modeling has confirmed that the concentrations of hazardous air pollutants result in a risk to the closest residential receptor of less than 1×10^{-6}; therefore, control technologies are not required pursuant to this ARAR.

Table 17. Summary of Action-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Discharge of Stormwater and Treated Groundwater	40 *CFR* § 122; 401 *KAR* 5:055; 401 *KAR* 5:031 and 5:026	Stormwater discharges from construction activities on-site are subject to the substantive requirements of the KPDES permit. This requires that BMPs to control storm water runoff and sedimentation be employed. Discharge of treated groundwater will be conducted in compliance with the substantive requirements of the KPDES program and the Clean Water Act. Provides chemical-specific numeric standards for pollutants discharged or found in surface waters. Provides chemical-specific numeric standards for pollutants in domestic water supplies.	The substantive requirements are considered applicable for all on-site construction or treatment activities where a discharge of storm water or treated groundwater occurs. Compliance with these ARARs shall be achieved by application of required controls during the construction and operation phases of the alternative. Consistent with CERCLA § 121(e)(1), no KPDES permit or permit modification will be required for on-site discharges of storm water, decontamination water, and treated groundwater. The applicable and substantive requirements will be met through the use of on-site treatment systems, which may include the Northwest Plume treatment system or C-613 Sedimentation Basin.

Table 17. Summary of Action-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Injection of groundwater into an underground source of drinking water.	40 *CFR* § 144.12	No owner or operator shall construct, operate, maintain, covert, plug, abandon, or conduct any other injection activity in a manner 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 under 40 *CFR* part 142 or may otherwise adversely affect the health of persons.	This action will involve reinjection of treated TCE contaminated groundwater into the electrodes of the treatment zone to improve efficiency of the remedial action. The treated groundwater to be injected at the electrodes is expected to have a significantly lower concentration (5 ppm or less) of TCE than when it initially was extracted from the same area (as high as 1,100 ppm). Hydraulic control will be maintained during operation by maintaining groundwater extraction at a greater rate than injection. The substantive requirements of the UIC program contained in 40 *CFR* § 144.12 and 40 *CFR* § 144.23(b)(1) are relevant and appropriate.
	40 *CFR* § 144.23(b)(1)	Prior to abandonment any Class IV well, the owner or operator shall plug or otherwise close the well in a manner acceptable to the Regional Administrator.	Abandonment of these borings will be accomplished as indicated in Section 11.4.10, Underground Injection Control.
	40 *CFR* § 144.13	Construction, operation, or maintenance of Class IV wells are prohibited except in cases where the reinjection of contaminated groundwater has undergone prior treatment, is being reinjected into the same formation from which it was drawn, and such injection is approved by EPA or a state, pursuant to provisions for cleanup of releases under CERCLA or RCRA.	The reinjection of the TCE-contaminated groundwater associated with the C-400 action meets the exception criteria outlined in 40 *CFR* § 144.13(c) and RCRA § 3020(b) and, therefore, is not prohibited by regulation or statute.

Table 17. Summary of Action-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Hazardous Waste Management	40 *CFR* § 260–264 and § 268; 401 *KAR* 31–34, 36 and 37	All wastes or environmental media containing wastes must be characterized to determine whether the waste also is a hazardous waste in accordance with 40 *CFR* § 262.11 and 401 *KAR* 32:010. If it is determined that a waste is a hazardous waste or that environmental media contains a hazardous waste subject to the RCRA regulation, the substantive requirements of 40 *CFR* § 262–268 are applicable.	The substantive requirements are ARAR and will be complied with through characterization of wastes and environmental media generated as a result of implementation of the alternative. Waste management will be predicated upon the characterization and will comply with all substantive requirements associated with hazardous waste management, if identified as such. Consistent with CERCLA § 121(e)(1), no RCRA permits (e.g., treatment permits) will be required for this action. The levels of 39.2 ppm TCE in solids and 0.030 ppm TCE in water will be used for contained-in/no-longer-contaminated-with determinations. Land Disposal Restrictions apply to media and debris that no longer contain or no longer are contaminated with RCRA regulated waste.
PCB Waste Management	40 *CFR* § 761	TSCA requirements for the management of PCB wastes or items containing ≥ 50 ppm PCBs or from a source of 50 ppm or greater. Requirements include the following: Management of waste and material; Characterization of PCB-containing materials; Labeling and storage for disposal; Manifest completion for shipment off-site; Decontamination of affected equipment or items; and Disposal of PCB wastes. These requirements will be complied with in the event that PCBs are found at concentrations requiring compliance with this part.	The substantive requirements are ARAR if PCBs are found or result from items or equipment regulated under 40 *CFR* § 761. Activities necessary to comply with these ARARs shall be incorporated into the planning phase of the alternative implementation.

Table 17. Summary of Action-Specific ARARs for Primary Source Area—Electrical Resistance Heating (Continued)

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
National Emission Standards for Hazardous Air Pollutants	401 *KAR* 57:002	The radiological dose to the most exposed member of the public resulting from sitewide radionuclide emissions to the atmosphere must not exceed 10 mrem/year.	The substantive requirements shall be complied with through calculation of emission levels for radionuclides during design and operation of the remedial action. Consistent with CERCLA Section 121(e)(1), no air permit will be required for the emissions of radionuclides.
Environmental Radiation Protection Standards for Nuclear Power Operations	40 *CFR* § 190, Subpart B	Requires that the annual dose equivalent to the public not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and radiation from these operations.	The substantive standards are considered ARAR and are equivalent to the NRC standards.

12. WASTE MANAGEMENT PLAN

12.1 OVERVIEW

This WMP is the primary document for management of waste that will be generated during implementation of a C-400 IRA to be conducted in the vicinity of the C-400 Building. Previous investigations indicate that elevated concentrations of TCE and its breakdown products exist in soils and groundwater and that free-phase DNAPL exists in the UCRS soil at the south end of the C-400 Building. In addition, TCE concentrations detected in the RGA suggest that free-phase DNAPL is in the RGA in the same area and is acting as a secondary source of groundwater contamination. A major component of this IRA is the removal of free-phase TCE and the reduction of dissolved-phase concentrations of TCE and its breakdown products in the soils in the C-400 Cleaning Building area through removal and treatment using ERH. These actions will produce the waste materials covered by this WMP.

This WMP addresses the management of wastes generated on this project from the point of generation through final disposition. The C-400 IRA is being conducted as a part of the environmental restoration activities at PGDP. The DOE contractor will be responsible for waste management activities associated with this project. Standard practices and procedures outlined in this WMP regarding the generation, handling, transportation, and storage of waste will comply with all DOE requirements, RCRA requirements, and the TSCA requirements (should PCBs become an issue).

A copy of this WMP will be available on-site during fieldwork. Copies of the plan will be issued to the DOE contractor WMC, who will be responsible for daily oversight of all waste management activities and for ensuring overall compliance with the WMP.

The approach outlined in this WMP emphasizes the following objectives:

- Management of the waste in a manner that is protective of human health and the environment;
- Minimization of waste generation, thereby reducing unnecessary costs (e.g., analytical costs), and use of the permitted storage and disposal facilities that are limited in number;
- Compliance with ARARs; and
- Selection of storage and/or disposal alternative(s) for the waste.

Waste management activities must comply with this WMP, ARARs, applicable procedures, the site WAC, and WAC for other specific treatment, storage, and disposal facilities (TSDFs) that are designated to receive the waste. The decision has not been made as to the final TSDF that will be used. Potential off-site TSDFs that may be used include, but are not limited to, Energy*Solutions*, Nevada Nuclear Security Site, Perma-Fix, and Waste Control Specialists.

During the course of this project, additional PGDP and DOE waste management requirements may be identified. Necessary revisions to the WMP will ensure the inclusion of these additional requirements into the daily activities of waste management personnel. DOE will inform the FFA parties of any substantive changes to the WMP or to any other of the C-400 project CERCLA documents, and changes will be made in accordance with Section XX.J, Subsequent Modification of Final Document, of the FFA.

12.2 WASTE GENERATION AND PLANNING

12.2.1 Waste Generation

A variety of waste will be generated during this project, including soil cuttings and water from drilling activities in the UCRS and RGA; treatment media (carbon, ion exchange resin, zeolite, etc.) from operation of an on-site treatment facility; ERH process piping and equipment; debris generated from infrastructure removal activities around the C-400 Cleaning Building; and sample residuals collected from borings within areas with known TCE/TCA contamination. As such, the waste generated from field-related activities has the potential to contain contaminants related to known or suspected past operations; therefore, this waste must be stored and disposed of in accordance with ARARs. Waste that is likely to have either hazardous or radiological contamination typically will be stored on-site in containers in CERCLA waste storage areas in accordance with PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Storage of Regulated Waste Materials at Paducah*, during the characterization period and prior to treatment/disposal. Consistent with EPA Policy, the generation, storage, and movement of waste during a CERCLA project and storing it on-site does not trigger the administrative RCRA storage or disposal requirements. On-site waste storage areas will be managed in accordance with the substantive RCRA hazardous waste storage standards. Among the substantive requirements are compatible containers in good condition, regular inspections, containment to control spills or leaks, and characterization of run-on and run-off, either by process knowledge or by sampling. In the event that any wastes are stored in temporary staging piles, plastic sheeting will be placed on the ground under the waste, and additional plastic sheets will be used to cover it to prevent the spread of contamination from rainfall in accordance with substantive RCRA standards for such piles. Final disposition of the materials will depend on final characterization.

Sections 12.2.2 through 12.2.11 provide a brief description of each potential waste stream. As discussed in the ROD (DOE 2005a), page A-5, a SAP is required as part of the WMP for waste characterization. Section 8.3 of this RAWP serves as the SAP required by page A-5 of the ROD (DOE 2005a).

12.2.2 Drill Cuttings from Soil Borings

Drilling cuttings will be generated from installation of the new soil borings and wells. It is assumed that all drill cuttings will have a 25 percent swell factor. An estimated total of 4,015 ft^3 of this waste is expected to be generated.

All drill cuttings will be containerized as they are generated, labeled, and managed on-site according to the substantive requirements of RCRA, until they are either determined not to be RCRA waste or dispositioned to an appropriate disposal facility. Wastes will be stored in a CERCLA storage area during characterization. The CERCLA storage area is managed according to the substantive requirements of RCRA. The soil will be sampled and analyzed as described in Section 8.3 for proper waste determination.

Drill cutting waste may be containerized in drums, ST-90 boxes, or 25-yd^3 IM containers during generation. The IM is preferred because it is the most reusable container and its greater size reduces both physical risk and cost by minimizing container movements as well as sampling activities. Dry drill cuttings generally will be loaded first into a self-tipping hopper attached to a forklift. The hopper will be dumped into the top of an IM that, at least, has been partially lined with a ploy liner to facilitate unloading and decontamination. This operation will continue until the IM container is approximately half-full, ensuring that the weight limit for the transport vehicle is not exceeded. If sampling does not occur prior to loading waste into the IM then the waste will be sampled for waste characterization as discussed in Section 8.3.3.1.

A portion of the drill cuttings from inside the areas mapped to have free-phase DNAPL may be determined to be characteristically hazardous and will be managed on-site in accordance with substantive requirements of RCRA. Wastes determined to be hazardous will be transferred to an on-site, permitted RCRA storage facility until such time as it is transferred off-site to an approved RCRA treatment and disposal facility.

The remainder of the drill cuttings that are not from the mapped areas of free-phase DNAPL is assumed not to be characteristically hazardous. This waste will be characterized and the concentrations of listed constituents, TCE and 1,1,1-TCA, will be compared to health-based levels for a "no longer contains" determination. If the concentrations are less than health based levels, the waste will not be managed as a RCRA-listed waste. If analytical results show that this waste meets the WAC of the C-746-U Landfill, the waste will be disposed of there as nonhazardous waste.

12.2.3 Personal Protective Equipment

PPE will be worn as specified in the HASP, Chapter 7 of this work plan, by personnel performing the field tasks during the C-400 IRA. While site personnel use procedures and BMPs to minimize opportunities for contacting TCE contaminated media and equipment, it is likely that some PPE or related debris (e.g., plastic sheeting) will come into contact with TCE-contaminated materials during the remediation process. Process knowledge, visual inspections, or direct sampling will be used to characterize PPE and any related debris. Based on the results of the characterization, any PPE or the related debris determined by site personnel 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 pursuant to Section 8.3.1. In cases where site personnel conclude, based on the above characterization process, that the PPE or related debris has not been contaminated by a listed waste or does not exhibit a characteristic, then the materials will not be considered a RCRA hazardous waste. An estimated total 205 ft^3 of this waste is expected to be generated as nonhazardous waste.

12.2.4 Purge/Decontamination/Drilling Water

Wastewater will be generated during the installation and development of newly constructed soil borings. An estimated total of 452,000 gal of this waste is expected to be generated during approximately nine months of drilling activities.

Groundwater associated with the C-400 site is contaminated with certain VOCs that originated from the release of solvents and the disposal of spent solvents. As a result, the TCE contamination in the C-400 groundwater has been declared a RCRA listed hazardous waste (code F001, F002, U228). Additionally, 1,1,1-trichloroethane (1,1,1-TCA), also a RCRA hazardous waste constituent associated with F001 and F002, has been detected at low levels. Under the EPA "contained-in" policy, environmental media, such as groundwater, must be managed as hazardous waste if they "contain" listed hazardous waste. EPA guidance, *Management of Remediation Waste under RCRA*, recommends that "contained-in" determinations use conservative, health-based standards to develop site-specific health-based levels of hazardous constituents below which contaminated environmental media would be considered to no longer contain hazardous waste (EPA 1998). Consequently, per the EPA's contained-in policy, the groundwater is considered to contain the RCRA-listed hazardous waste. Management of such groundwater must comply with the RCRA ARARs, unless the groundwater is determined to contain TCE below the health-based levels. The site-specific health-based level for TCE in groundwater at PGDP has been established at 30 ppb, which is based on Kentucky ambient water quality criteria for protection of human health for consumption of fish [401 *KAR* 10:031 § 6(1)]. Groundwater contaminated with TCE at or below 30 ppb will be considered to no longer contain the RCRA-listed hazardous waste (F001, F002, and U228). Groundwater that meets the health-based level for TCE also shall be deemed to no longer contain

1,1,1-TCA. Degradation products (*cis*-1,2-DCE*;* *trans*-1,2-DCE; or vinyl chloride) associated with TCE may be present in groundwater, and any treatment process used for the TCE-contaminated groundwater also would be effective in treating/reducing the concentrations of the degradation products. Most of the contaminated groundwater extracted for treatment exceeds this site-specific health-based level; thus, it must be managed as RCRA-listed hazardous waste. The treated groundwater that is discharged into the receiving surface water body (e.g., Bayou Creek) will comply with identified Clean Water Act and Kentucky water quality standards identified as ARARs and will be below the 30 ppb TCE. Pursuant to 40 *CFR* § 261.4(a)(2) (401 *KAR* 31:010 § 4), point source discharges are excluded from regulation as a hazardous wastes. Wastewater will be accumulated and stored on-site until it can be processed through the on-site C-752-C treatment unit for removal of suspended solids, as necessary. The C-752-C treatment unit meets the definition of a wastewater treatment unit in 40 *CFR* § 260.10 and can process water at a rate of approximately 1,200 gal per day. After solids removal, the water will be collected in a manner that will minimize the possibility of spills; then it will be sampled to ensure it meets the appropriate acceptance criteria and treated at the on-site C-400 IRA water treatment facility or transported to the on-site C-612 Northwest Plume Groundwater System, the on-site C-613 Sediment Basin, or other acceptable facility for treatment and/or disposal through KPDES-permitted Outfall 001. The C-400 IRA water treatment facility and the C-612 facility both have adequate additional capacity to treat the 1,200 gal per day produced generated through C-752-C. The 452,000 gal of treated drilling, purge, and decontamination water to be discharged through Outfall 001 is a small fraction of the approximately 800,000,000 gal released annually to this outfall from current sources.

Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES Outfalls or on-site ditches that flow to permitted KPDES Outfalls.

The proposed target analytes for this waste are those required to meet KPDES discharge limits and include TCE, PCBs, oil and grease, total residual chlorine, total phosphorous, total metals, Tc-99, hardness, dissolved and suspended alpha, beta, total uranium, and pH.

12.2.5 Sediment and Mud from Separation of Decontamination and Purge Water

Decontamination water and mud (soil sediment/mud) will be generated during cleaning of the drilling and sampling equipment. An estimated total of 375 ft^3 is expected to be generated. The water will be collected in a sump in the decontamination facility, decanted on-site, and collected in a manner that will minimize the possibility of spills, to the extent possible, and added to the Purge/Decontamination/Drilling water waste stream described in Section 12.2.4. The mud will be containerized as it is removed from the sump, then sampled and managed similarly to drill cuttings (Section 12.2.2).

12.2.6 Treated Groundwater

An aboveground treatment system will be installed to treat groundwater extracted during operation of the ERH process. The treatment system will remove VOCs and Tc-99 from the groundwater prior to discharge to an on-site ditch, which drains to KPDES-permitted Outfall 001. The system will have a treatment capacity of approximately 80 gal per minute (gpm). During Phase I operations, the system operated at approximately 30 to 50 gpm. During Phase II, the system is expected to operate between 45 to 65 gpm. At full capacity of 80 gpm, the C-400 treatment system discharge will only increase the overall flow to Outfall 001 by approximately 5%.

The treatment system influent and discharge design parameters are shown in the Table 18.

Table 18. Liquid Treatment System Design Parameters and Discharge Criteria Relative to Outfall 001

Analyte/Design Parameter	Influent	Discharge Limit
Groundwater flow	20–80 gpm	N/A
Condensate flow	10 gpm max	N/A
TCE concentration	5–1,100 ppm	30 ppb[a]
1,1-DCE concentration	154 ppb	3.2 ppb[a]
Tc-99 activity	14-342 pCi/L (observed in groundwater sampled during the Six-Phase Treatability Study and Phase I)	900 pCi/L[b]
Temperature	203˚F (95˚C) maximum 18˚F (85˚C) average	89˚F (31˚C) daily max[c]
pH	5.5–6.5	6–9[c]
Total suspended solids	10–50 ppm	30 mg/L monthly average[c] 60 mg/L daily max[c]
Total residual chlorine	Plant potable water levels	0.011 mg/L monthly average[c] 0.019 daily max[c]

[a] Discharge limits are based on 401 *KAR* 5:031.
[b] DOE target limit.
[c] KPDES permit limit for Outfall 001 effluent discharge.

During system startup and testing treated water will be sampled prior to discharge to verify that the system is adequately treating the groundwater. During routine operations weekly samples of the system effluent will be analyzed to monitor ongoing performance of the treatment system.

Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES Outfalls or on-site ditches that flow to permitted KPDES Outfalls.

12.2.7 Carbon Media, Ion Exchange Resin, Zeolite Media, and Cloth Filters

During the implementation of the C-400 IRA, the aboveground treatment system will contain several types of media used in the treatment of VOC-contaminated extracted groundwater and vapors including activated carbon, ion exchange resin, zeolite, and cloth filters. In addition to VOCs, other laboratory analyses conducted on these wastes include TCLP SVOCs and metals and total radiological (RAD). If any of these analyses indicate that the waste is characteristically hazardous or a listed-hazardous waste, the waste will be managed and disposed of as such.

The carbon, ion exchange resin and zeolite are recyclable, which is the preferred disposition for these materials if health physics (HP) survey indicates that radiological contamination is less than free-release limits. If the analytical results show that the wastes are not characteristically hazardous but the HP survey indicates that radiological contamination is too high for recycling (free release), but less than the authorized limits of the C-746-U Landfill, they will be disposed of there if other disposal criteria are met. An estimated total of 8,000 ft^3 of carbon media is expected to be generated. Spent filter cloths are included with the PPE waste estimate stated in Section 12.2.3 since they are a similar waste stream. No ion exchange resin or zeolite filter media are expected to become waste streams during the Phase IIa project.

12.2.8 Infrastructure Removal Debris

Site preparation will include removal of interfering C-400 infrastructure. In the southeast treatment area, a concrete loading dock wall will be removed to allow for drilling and installation of ERH components. An estimated 540 ft^3 of concrete and debris will be generated from this project.

12.2.9 DNAPL VOC

To accomplish the mass reduction of VOCs (primarily TCE and its breakdown products) in the C-400 area, free-phase DNAPL VOCs will be recovered by the aboveground treatment system. All liquid phase VOCs will be containerized, labeled, and managed according to the substantive requirements of RCRA while on-site. The analytical results are expected to exceed the levels listed in Section 8.3.1; therefore, the liquid VOCs are expected to be treated at an off-site RCRA-permitted hazardous waste facility. Other target analytes for this waste are SVOCs, metals, and total RAD. An estimated total of approximately 2,500 gal of this waste is expected to be generated from this project.

12.2.10 Process Piping, Equipment, and Well Abandonment Waste

During the implementation of the C-400 IRA, a subsurface ERH treatment system and an aboveground treatment system will be constructed and operated. Following completion of the C-400 IRA, the process piping and equipment from these systems will be dismantled. Equipment from the aboveground portions of the treatment system will be dismantled and removed from the site. A portion of the equipment will be leased or rented equipment that will be returned to the appropriate vendor following decontamination activities. The remaining equipment and process piping is expected to be recycled or disposed of in the C-746-U Landfill, as appropriate. If scrap metal is able to be recycled under 40 *CFR* § 261.6(a)(3)(ii), the waste is exempt from regulation as a hazardous waste. Any hazardous waste that has residual solvents on it will be decontaminated per 40 *CFR* § 268.45 and disposed of as nonhazardous according to the provisions of 40 *CFR* § 268.45(c) and 40 *CFR* § 261.3(f)(1). Any process piping and equipment that cannot be successfully decontaminated will be disposed of off-site at a RCRA-permitted hazardous waste facility. An estimated total of 3,780 ft^3 of this waste is expected to be generated.

Approximately 1,500 ft^3 of waste will be generated during abandonment of ERH subsurface components, including piezometers from the Six-Phase Treatability Study. The waste generated from these activities will be stored at the C-760 CERCLA storage area during characterization. Wastes determined to be hazardous will be transferred to an on-site permitted RCRA storage facility until such time as it is transferred off-site to an approved RCRA treatment and disposal facility. See Sections 11.4.4 and 11.4.10 for details regarding abandonment of ERH subsurface components.

12.2.11 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 office paper, aluminum cans, packaging materials, and glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items. During implementation of this WMP, all clean trash will be segregated according to those guidelines and then collected and recycled/disposed of by the WMC once it has been approved for removal. An estimated total of 500 ft^3 of this waste is expected to be generated.

12.3 WASTE MANAGEMENT ROLES AND RESPONSIBILITIES

12.3.1 Waste Management Tracking Responsibilities

Waste generated during sampling activities at PGDP will require a comprehensive waste-tracking system capable of maintaining an up-to-date inventory of waste. The inventory database will be used to store data that will enable determination of management, storage, treatment, and disposal requirements for the waste.

12.3.2 Waste Management Coordinator

The WMC will ensure that all waste activities are conducted in accordance with PGDP facility requirements and this WMP. Responsibilities of the WMC also include coordinating activities with field personnel, overseeing daily waste management operations, and maintaining a waste management logbook that contains a complete history of generated waste and the current status of individual waste containers. Designated waste operators also may complete the waste management logbook.

The WMC will ensure that procurement and inspection of equipment, material or services critical for shipments of waste to off-site TSDFs are conducted in accordance with appropriate procedures. In addition, the WMC will ensure that wastes are packaged and managed in accordance with applicable requirements (e.g., the WAC for the landfill).

Additional responsibilities of the WMC include the following:

- Maintaining an adequate supply of labels;
- Maintaining drum inventories at sites;
- Interfacing with all necessary personnel;
- Preparing Requests for Disposal;
- Tracking generated waste;
- Ensuring that drums are properly labeled;
- Coordinating waste recycling, disposal, or transfers;
- Sampling waste containers to characterize wastes;
- Coordinating pollution prevention and waste minimization activities;
- Transferring characterization data to DOE prime contractor’s data manager; and
- Ensuring that temporary project waste storage areas are properly established, maintained, and closed.

The WMC and waste operators will perform the majority of waste handling activities. These activities will involve coordination with the DOE prime contractor IRA project manager or designee who will perform periodic inspections to verify that drums are labeled in accordance with the WMP guidelines.

The WMC will be responsible for ensuring characterization sampling of the waste in accordance with the procedures outlined in this plan. When sampling is complete, the WMC will transfer the waste into the waste holding area established for this project, if necessary.

12.3.2.1 Coordination with Field Crews

The WMC will be responsible for daily coordination with all field crews involved in activities that generate waste. The WMC will perform daily rounds of each of the work sites to oversee the waste collection and will verify that procedures used by the field crews comply with the WMP guidelines. Deficiencies will be documented in the waste management logbook, and appropriate direction will be given to the field crews. Site visits will be documented in the field logbook.

12.3.3 Coordination with Treatment, Storage, and Disposal Facilities

The waste streams generated on the C-400 IRA may be managed and disposed of in a variety of ways depending on characterization and classification. Waste will be temporarily stored on-site as previously discussed. Waste that is to be shipped to an off-site TSDF must be done so in accordance with applicable DOE contractor procedures and U.S. Department of Transportation requirements.

12.3.4 Waste Management Training

The WMC and other project personnel with assigned waste management responsibilities will be trained and qualified in accordance with DOE contractor-approved Training Position Descriptions.

12.4 TRANSPORTATION OF WASTE

The areas where the C-400 IRA activities will be conducted are on DOE property. Transportation of waste on DOE property will be conducted in accordance with applicable DOE, PGDP, and DOE prime contractor policies and procedures. In the event that it becomes necessary to transport known or suspected hazardous waste over public roads, coordination will be initiated with PGDP Security, as necessary, which may result in the temporary closing of roads. Once hazardous wastes are transported from a CERCLA site, they are subject to full RCRA regulation; therefore, all transportation and TSDF requirements under RCRA must be followed. Off-site shipments must be accompanied by a manifest. Off-site disposal of hazardous wastes will occur only at a RCRA facility in a unit in full compliance with the Subtitle C requirements. Transportation of known or suspected hazardous waste on public roads will be conducted in accordance with applicable U.S. Department of Transportation regulations (*CFR* Title 49).

12.4.1 Screening of Analytical Samples

During the course of the C-400 IRA field activities, screening of samples in the field and in an on-site laboratory routinely will be performed to protect the health and safety of on-site personnel to ensure compliance with regulatory requirements.

12.4.2 Field Screening

Field screening for health and safety will be conducted during project field activities and sample collection. The field screening to be performed will incorporate the use of instrumentation to monitor for organic vapors, as well as radiation meters capable of detecting alpha and beta/gamma radioactivity. An elevated reading from field monitoring may be cause for reevaluation of current waste classification, labeling, and handling activities.

12.4.3 On-Site Laboratory Radiation Screening

A fixed-base laboratory will analyze all waste characterization samples. All samples to be shipped off-site for laboratory analysis will be screened for radiation at an on-site laboratory before shipment and will receive approval for off-site shipment.

12.5 SAMPLE RESIDUALS AND MISCELLANEOUS WASTE MANAGEMENT

The SMO-approved analytical laboratory that has been audited under DOECAP will generate sample residuals and laboratory wastes. The laboratory will manage and return waste sample residuals to the project. Nonhazardous wastes generated during analyses will be disposed of by the laboratory.

12.6 WASTE MINIMIZATION

Waste minimization requirements that will be implemented, as appropriate, include those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, 435.1; and DOE contractor's requirements. Requirements specified in the DOE contractor's WMP regarding waste generation, waste tracking, waste reduction techniques, and the waste reduction program, in general, also will be implemented.

To support DOE's commitment to waste reduction, an effort will be made during field activities to minimize waste generation as much as possible, largely through ensuring that potentially contaminated wastes are localized and do not come into contact with any clean media (which could create more contaminated waste). Waste minimization also will be accomplished through waste segregation, immediate containerization of waste, selection of PPE, and waste handling (spill control). Efforts will be made to avoid stockpiling soil waste, use coveralls only when necessary, attempt to reuse coveralls, and segregate visibly soiled coveralls from clean coveralls.

12.7 HEALTH AND SAFETY ISSUES RELATED TO WASTE ACTIVITIES

Waste management activities will be conducted in accordance with health and safety procedures documented in the HASP included as Section 7 of this work plan.

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APPENDIX A

CD—*REMEDIAL DESIGN REPORT, CERTIFIED FOR CONSTRUCTION DESIGN DRAWINGS AND TECHNICAL SPECIFICATIONS PACKAGE, FOR THE GROUNDWATER OPERABLE UNIT FOR THE PHASE IIA VOLATILE ORGANIC COMPOUND CONTAMINATION AT THE C-400 CLEANING BUILDING AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY*

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APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

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QAPP WORKSHEETS

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ACRONYMS

CAB	Citizens Advisory Board
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chain-of-custody
COPC	chemical of potential concern
CR	Condition Report
CRQL	contract-required quantification limit
DOECAP	U.S. Department of Energy Consolidated Audit Program
DMC	document management center
DOE	U.S. Department of Energy
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture detector
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
FID	flame ionization detector
FFA	Federal Facility Agreement
GC	gas chromatograph
ID	identification
IRA	interim remedial action
KDEP	Kentucky Department for Environmental Protection
KY	Commonwealth of Kentucky
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
MBWA	management by walking around
MCL	maximum contaminant limit
MDL	method detection limit
MIP	membrane interface probe
MS	mass spectroscopy
N/A	not applicable
NAL	no action level
NCR	Nonconformance Report
NRDA	National Resource Damage Assessment
OREIS	Oak Ridge Environmental Information System
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PT	proficiency testing
QA	quality assurance
QC	quality control
QAPP	quality assurance project plan
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
RAWP	Remedial Action Work Plan
RCT	radiological control technician
RGA	Regional Gravel Aquifer
RPD	relative percent difference
SOP	standard operating procedure
SVOC	semivolatile organic compound

TBD	to be determined
TCE	trichloroethene
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
WAG	waste area group

QAPP Worksheet #1
Title Page

Document Title: *Remedial Action Work Plan for Phase IIa of the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (RAWP)

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

Preparer's Name and Organizational Affiliation: LATA Environmental Services of Kentucky, LLC (LATA Kentucky)

Preparer's Address, Telephone Number, and E-mail Address: 761 Veterans Avenue, Kevil, KY, 42053, Phone (270) 441-5000

Preparation Date (Month/Year): 06/2012

Document Control Number: DOE/LX/07-1271&D2

LATA Kentucky Environmental Remediation Project Manager	Signature Mark J. Duff	7-2-12 Date
LATA Kentucky Regulatory Manager	Signature Myrna Espinosa Redfield	7/2/12 Date
LATA Kentucky Sample/Data Management Manager	Signature Lisa Crabtree	6/29/12 Date

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Paducah Gaseous Diffusion Plant (PGDP)

Site Location: Paducah, Kentucky

Site Number/Code: KY8890008982

Contractor Name: LATA Environmental Services of Kentucky, LLC

Contractor Number: DE-AC30-10CC40020

Contract Title: Paducah Gaseous Diffusion Plant Paducah Environmental Remediation Project

Work Assignment Number: N/A

1. Identify guidance used to prepare Quality Assurance Project Plan (QAPP):

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

   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

   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

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 entity: 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: March 2007

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

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

Title:	**Approval Date:**
Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities, DOE/OR/07-1595&D2 (DOE 1998b)	10/5/1998
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-1269&D1 (DOE 2012)	Pending
March 1, 2011, addendum of the *Remedial Action Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0004&D2/R2/A1/R2 (DOE 2011b); to include *Field Sampling Plan for Developing Predictive Relationships and Augmentation of the Results of the Membrane Interface Probe Logs of the Southeast C-400 Dense Nonaqueous-Phase Liquid Area at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*	March 14, 2011

7. List organizational partners (stakeholders) and connection with lead organization:

   DOE, EPA Region 4, KDEP

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

9. If any required QAPP elements and required information are not applicable to the project, then indicate the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion here.

   No elements specifically are omitted from this QAPP.

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
Project Management and Objectives		
2.1 Title and Approval Page	• Title and Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	• Table of Contents • QAPP Identifying Information	2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	• Distribution List • Project Personnel Sign-Off Sheet	3, 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	• Project Organizational Chart • Communication Pathways • Personnel Responsibilities and Qualifications Table • Special Personnel Training Requirements Table	5, 6, 7, 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	• Project Planning Session Documentation (including Data Needs tables) • Project Scoping Session Participants Sheet • Problem Definition, Site History, and Background • Site Maps (historical and present)	9, 10
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	• Site-Specific Project Quality Objectives • Measurement Performance Criteria Table	11, 12
2.7 Secondary Data Evaluation	• Sources of Secondary Data and Information • Secondary Data Criteria and Limitations Table	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	• Summary of Project Tasks • Reference Limits and Evaluation Table • Project Schedule/Timeline Table	14, 15, 16

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	• Sampling Design and Rationale • Sample Location Map • Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table • Analytical Methods/SOP Requirements Table • Field Quality Control Sample Summary Table • Sampling SOPs • Project Sampling SOP References Table • Field Equipment Calibration, Maintenance, Testing, and Inspection Table	17, 18, 19, 20, 21, 22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	• Analytical SOPs • Analytical SOP References Table • Analytical Instrument Calibration Table • Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	23, 24, 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	• Sample Collection Documentation Handling, Tracking, and Custody SOPs • Sample Container Identification • Sample Handling Flow Diagram • Example Chain-of-Custody (COC)Form and Seal	26, 27
3.4 Quality Control (QC) Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	• QC Samples Table • Screening/Confirmatory Analysis Decision Tree	28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	• Project Documents and Records Table • Analytical Services Table • Data Management SOPs	29, 30

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	• Assessments and Response Actions • Planned Project Assessments Table • Audit Checklists • Assessment Findings and Corrective Action Responses Table	31, 32
4.2 Quality Assurance (QA) Management Reports	• QA Management Reports Table	33
4.3 Final Project Report		
Data Review		
5.1 Overview	N/A	N/A
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	• Verification (Step I) Process Table • Validation (Steps IIa and IIb) Process Table • Validation (Steps IIa and IIb) Summary Table • Usability Assessment	34, 35, 36, 37
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining	N/A	N/A

QAPP Worksheet #3
Minimum Distribution List

The distribution for this project-specific QAPP will be the same as that used for other FFA documents. Below is the current version of this list.

Standard Distribution List—FFA Documents

REGULATORY DISTRIBUTION				
	D1 and D2 Documents			
	Document	Redline[a]	E-copy[b]	CD
Environmental Protection Agency (EPA)				
Turpin Ballard/Jennifer Tufts (original letter)	2	1	✓	✓
Jana Dawson, TLI (copy of letter)	1	-	✓	✓
State of Kentucky (KY)				
Todd Mullins (original letter)	3	1	✓	3
Gaye Brewer (copy of letter)	1	-	✓	1
U.S. Department of Energy (DOE)				
DOE[c]	1	1	✓	1
Citizens Advisory Board (CAB)[d]	-	-	-	2
LATA Environmental Services of Kentucky, LLC (LATA Kentucky)[e]				
Document Management Center (DMC)				
DMC-RC (unbound)	1	1	✓	-
Administrative Record (unbound)	1	1	✓	1
National Resource Damage Assessment (NRDA) Trustees				
Kentucky Department of Fish & Wildlife				
Tim Kreher	-	-	-	1
Kentucky Energy and Environment Cabinet				
Dr. Len Peters, Cabinet Secretary	-	-	-	1
Tennessee Valley Authority				
Cynthia Anderson	-	-	-	1
Robert Casey	-	-	✓	-
A. Stephens	-	-	✓	-
U.S. Fish & Wildlife				
Tony Velasco	-	-	-	1
TOTAL DISTRIBUTION	10	5	-	15

[a] For KY, one redlined hard copy is sufficient if the document is less than 100 pages. If the document is greater than 100 pages, KY would like an additional redlined hard copy. For D2 documents, DOE has requested 3 redlined copies and 8 comment response summaries (CRS). Two additional redlined copies will be generated for the AR file and for the DMC file if the DOE letter cites that a redlined copy is enclosed. CRSs in response to DOE comments are provided to DOE only.
[b] Electronic distribution will be made via e-mail for documents less than 10 MB, otherwise the link to the Public Documents Web site will be provided. DOE will be responsible for sending the e-copy e-mail. LATA Kentucky is responsible for posting to the Public Documents Web site.
[c] CDs are provided to Kim Crenshaw.
[d] Environmental Reporting and Deliverables Quality (ERDQ)/Document Production (within the Regulatory Management group) will provide CDs to Eddie Spraggs who will make distribution of the CDs.
[e] Additional copies needed for LATA Kentucky personnel are not included in the above totals. ERDQ will provide copies to the appropriate administrative staff to complete distribution of these documents.

QAPP Worksheet #4
Project Personnel Sign-Off Sheet

Personnel actively engaged in sample collection, data analysis, and data validation for the projects are required to read applicable sections of this project-specific QAPP upon approval of its contents by all FFA parties. The master list of signatures will be kept with the project work control documentation and will be made available upon request.

Project Position Title	Organization	Signature	Date
Project Manager			
Task Lead			
Data Coordinator			
Data Validator			
Data Reviewer			
QA Specialist			
Project Geologist			
Environmental Sampling Lead			

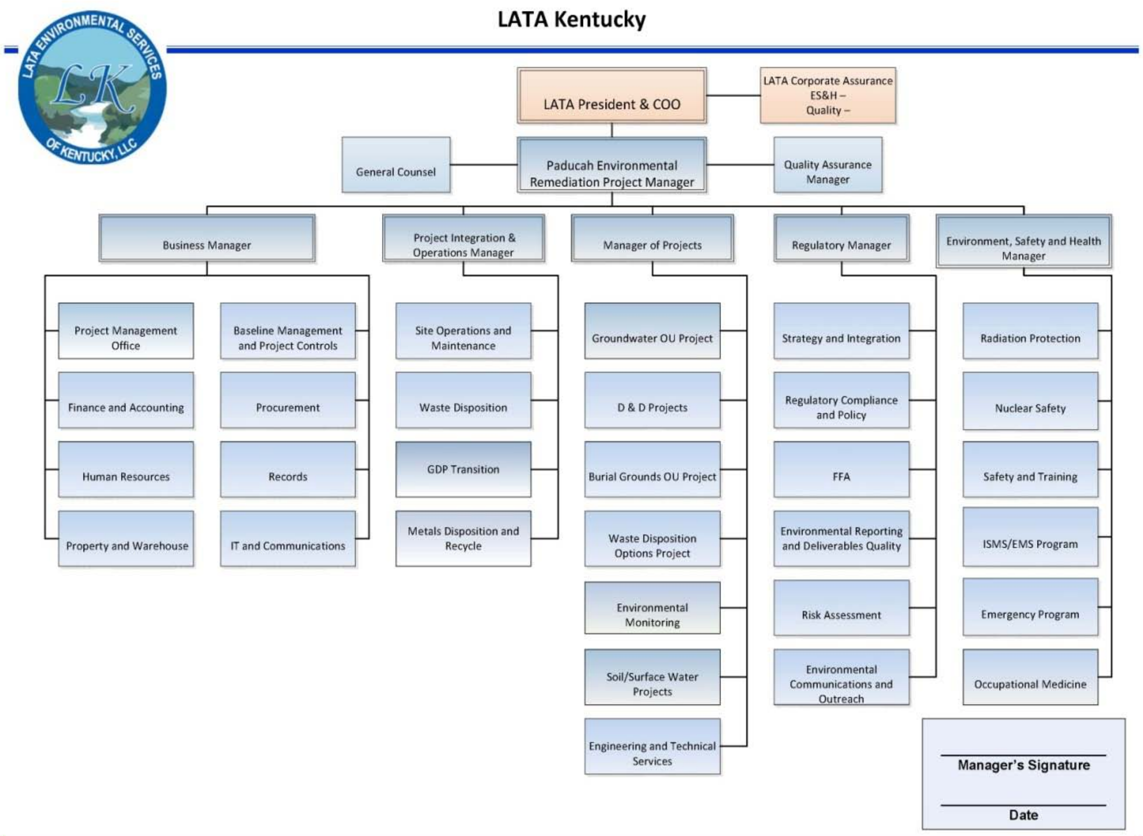
BACK

TABLE OF CONTENTS

FORWARD

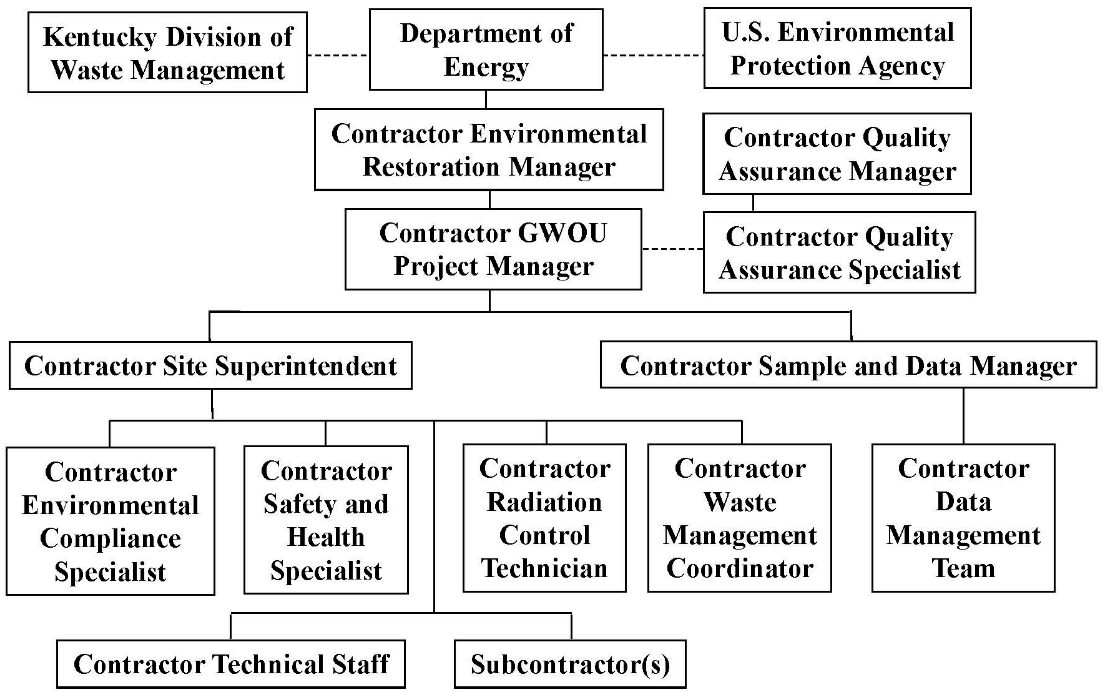
QAPP Worksheet #5-A
Project Contractor Organizational Chart*

This portion of the QAPP addresses the project organization as it provides for QA/QC coordination and responsibilities. This QAPP includes the overall project organization at the Remediation Project Manager level and its principal lines of communication and authority.



* A copy of the current organizational chart will be maintained at the LATA Kentucky Web site.

QAPP Worksheet #5-B
Project Level Organizational Chart



QAPP Worksheet #6
Communication Pathways

NOTE: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as e-mail, meetings, etc., will occur throughout the project.

Communication Drivers	Organizational Affiliation	Position Title Responsible	Procedure
Federal Facility Agreement DOE/OR/07-1707	DOE Paducah	DOE Federal Facility Manager	All formal communication among DOE, EPA, and KDEP
Federal Facility Agreement DOE/OR/07-1707	DOE Paducah	Environmental Remediation Project Manager	All formal communication between DOE and contractor for Environmental Remediation Projects
All project requirements	LATA Kentucky	Environmental Remediation Project Manager	All formal communication between the project and the Site Lead
All project requirements	LATA Kentucky	Project Manager	All communication between the project and the LATA Kentucky Environmental Remediation Project Manager
Project QA requirements	LATA Kentucky	Quality Assurance Manager	All project quality related communication between the QA department and LATA Kentucky project personnel
FFA Compliance	LATA Kentucky	Regulatory Manager	All internal communication regarding FFA compliance with the LATA Kentucky Project Manager

QAPP Worksheet #6 (Continued)
Communication Pathways

Communication Drivers	Organizational Affiliation	Position Title Responsible	Organizational Department Manager	Procedure
Sampling Requirements	LATA Kentucky	Sampling Lead	Project and Operations Manager	All internal communication regarding field sampling with the LATA Kentucky Project Manager
Analytical Laboratory Interface	LATA Kentucky	Laboratory Coordinator	Project and Operations Manager	All communication between LATA Kentucky and analytical laboratory
Waste Management Requirements	LATA Kentucky	Waste Coordinator	Project and Operations Manager	All internal communication regarding project waste management with LATA Kentucky Project Manager
Environmental Compliance Requirements	LATA Kentucky	Compliance Manager	Regulatory Manager	All internal correspondence regarding environmental requirements and compliance with the LATA Kentucky Project Manager
Subcontractor Requirements (if applicable)	LATA Kentucky	Subcontract Administrator	Business Manager	All correspondence between the project and subcontractors, if applicable
Health and Safety Requirements	LATA Kentucky	Environment, Safety, and Health Manager	Environment, Safety, and Health Manager	All internal communication regarding safety and health requirements with the LATA Kentucky Project Manager

Roles presented above are at the program level.
NOTE: In the event the contractor changes, DOE will notify EPA and KDEP of the change, but not request approval of the report.

QAPP Worksheet #7
Personnel Responsibility and Qualifications Table

Position Title Responsible	Organization Affiliation	Responsibilities	Education and Experience Qualifications
Project Manager	LATA Kentucky	Overall project responsibility	> 4 years relevant work experience
Environmental Engineer	LATA Kentucky	Project sampling and analysis plan	Bachelor of Science plus > 1 year relevant work experience
Environmental Compliance Manager	LATA Kentucky	Project environmental compliance responsibility	Bachelor of Science plus > 4 years work experience
FFA Manager	LATA Kentucky	Project compliance with the FFA	> 4 years relevant work experience
Environmental Monitoring and Reporting Program Manager	LATA Kentucky	Support project on sampling and reporting activities	> 4 years relevant work experience
Sample/Data Management Manager	LATA Kentucky	Project sample and data management	> 1 year relevant work experience
Health and Safety Representative	LATA Kentucky	Project safety and health responsibility	Bachelor degree plus > 1 year relevant experience
Waste Coordinator	LATA Kentucky	Overall project waste management responsibility	> 4 years relevant experience
Data Validator	Independent third party contractor	Performing data validation according to specified procedures	Bachelor degree plus relevant experience
Analytical Laboratory Project Manager	Analytical Laboratory	Sample analysis and data reporting	Bachelor degree plus relevant experience

QAPP Worksheet #8
Special Personnel Training Requirements Table

Personnel are trained in the safe and appropriate performance of their assigned duties in accordance with requirements of work to be performed. The special training requirements other than what normally is required for work at the PGDP site are listed below. QAPP development uses a graded approach. A work control package will be generated prior to implementation of the field sampling plan (FSP) the package will list specific project-level training requirements.

Project Function	Specialized Training—Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates*
Drill Rig Operator	Kentucky Certified Well Driller	State of Kentucky		Drill Rig Operator	Drill Rig Operator	

* Training records are maintained by the LATA Kentucky training department. If training records and/or certificates do not exist or are not available, this should be noted.

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Paducah Remediation Services, LLC, developed a draft of data quality objectives (DQOs) for pre- and postoperation characterization of volatile organic compound (VOC) contamination in soils and groundwater during March 2007. Documentation of the DQOs was reviewed internally and incorporated into the drafts of the Remedial Action Work Plan (RAWP), which have been reviewed by staff of DOE and the FFA oversight agencies, EPA and KDEP. Documentation of the review comments and revisions to the Data Quality Objectives and Sampling and Analysis Plan is present in comment response summaries for each draft version. The DOE/LX/07-0004&D2 version of the document (submitted June 19, 2008) incorporates the DQO comments in the Sampling and Analysis Plan based on the original scope of the interim remedial action, which was simultaneous application of electrical resistance heating (ERH) in the Regional Gravel Aquifer (RGA) and Upper Continental Resistance Heating (UCRS). (Subsequent versions have addressed revisions to the project's waste management approach and a separate field sampling plan to reassess DNAPL mass in the southeast C-400 area.)

With the consent of the FFA members, DOE's contractor divided ERH operations into two phases. Reviews of the performance of Phase I of the interim remedial action by a DOE Independent Technical Review Team and by LATA Kentucky revealed that ERH is likely to be ineffective in the RGA in Phase II. With the consent of EPA and KDEP, DOE developed *Revised Proposed Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1263&D1 (issued December 21, 2011), which documents the decision to split the Phase II interim remedial action into separate UCRS (Phase IIa) and RGA (Phase IIb) actions.

This QAPP and associated revisions to the Sampling and Analysis Plan in *Remedial Action Work Plan for Phase IIa of the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1271&D2, adapt the Sampling and Analysis Plan for a UCRS-only application.

Name of Project: Sampling and Analysis Plan for the C-400 RAWP
Date of Session: March 2007
Scoping Session Purpose: Characterize reduction in VOC levels with application of ERH

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Sr. Scientist	Formerly Paducah Remediation Services, LLC Currently LATA Kentucky	Kenneth Davis	270-441-5049	ken.davis@lataky.com	Author: Sampling and Analysis Plan

QAPP Worksheet #10
Problem Definition

The problem to be addressed by the project:

This remedial activity [Phase IIa of the C-400 Interim Remedial Action (IRA)] will address treatment of VOCs in soil and groundwater of the UCRS and the upper RGA in the southeast corner of the C-400 block that is believed to be a significant source of the larger groundwater contamination area identified as the Northwest Plume. RAOs defined in the Record of Decision (2005) include these:

1. Prevent exposure to contaminated groundwater by on-site industrial workers through institutional controls (e.g., excavation/penetration permit program);
2. Reduce VOC contamination [primarily trichloroethene (TCE) and its breakdown products] in UCRS soil at the C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure; and
3. Reduce the extent and mass of the VOC source (primarily TCE and its breakdown products) in the RGA in the C-400 Cleaning Building area to reduce the migration of the VOC contaminants to off-site points of exposure.

The remediation goal for this interim action, as documented in the revised Proposed Plan (December 2011), is to operate an ERH system in the UCRS and upper RGA until monitoring indicates that heating has stabilized in the subsurface and that recovery of TCE, as measured in the recovered vapor, diminishes to a point at which the recovery rate is constant (i.e., recovery is asymptotic).

During the design of the original C-400 IRA ERH system, DOE decided to divide the treatment system into two phases. Phase I was implemented in the source areas that are east and southwest of the C-400 Building: Phase I implementation was completed in December 2010. Based on the evaluation of the Phase I results and lessons learned, it was determined that the ERH base design was successful in reaching target temperatures in the subsurface and removing contaminants in the UCRS and upper RGA. The evaluation of Phase I also indicated that target temperatures were not achieved in the lower RGA, which has resulted in splitting the Phase II IRA for the southeast source areas into two separate actions:

1. UCRS and Upper RGA action (Phase IIa) and
2. Lower RGA action (Phase IIb).

The environmental questions being asked:

1. What are the initial VOC concentrations in UCRS and upper RGA soil in soil borings and groundwater in RGA wells of the Phase IIa IRA?
2. What are the postoperational VOC concentrations in UCRS and upper RGA soil in collocated soil borings of the Phase IIa IRA?

QAPP Worksheet #10 (Continued)
Problem Definition

Observations from any site reconnaissance reports:
Characterization data from the Waste Area Group (WAG) 6 RI (DOE 1999) and focused sampling at C-400 in 2010 to confirm earlier Membrane Interface Probe (MIP) logs indicate that significant TCE contamination of soil and groundwater is present.
A synopsis of secondary data or information from site reports:
Section 8 of the RAWP summarizes the secondary data used to document the DQOs.
The possible classes of contaminants and the affected matrices:
Primarily, the contaminants are VOCs.
Affected matrices are expected to be as follows (if present):
Soils, Groundwater
The rationale for inclusion of chemical and nonchemical analyses:
Worksheet #11 presents rationale for inclusion of chemical and nonchemical analyses.
Information concerning various environmental indicators:
Groundwater investigations have indicated that the Southeast C-400 block is a significant source of dissolved VOCs (primarily TCE) to the Northwest Plume.
Project decision conditions (“If..., then...” statements):
Project decision conditions (“If…, then…statement” for decisions) are inappropriate to the baseline and postoperations sampling (see related discussion in Section 8.1.2, Identify Decisions of the RAWP.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

DOE and its contractors (e.g., Performance Results Corporation, LATA Kentucky), KDEP, and EPA.

What will the data be used for?

To determine the percent reduction of VOC levels in the C-400 Cleaning Building Area as a result of the C-400 Phase IIA IRA.

What types of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)

Qualitative results using photoionization detector (PID) measurements. These qualitative results will be used to determine the depth interval to sample for VOCs analysis by a fixed-laboratory.

How "good" do the data need to be in order to support the environmental decision?

Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process. All fixed-laboratory data will be verified and assessed with 10% validated at Level IV.

How much data are needed? (number of samples for each analytical group, matrix, and concentration)

The numbers of samples to be submitted to the fixed-laboratories are identified in the RAWP and Worksheet #18. Additionally soil samples will be qualitatively evaluated in the field for VOCs utilizing a photoionization detector. Additional details regarding the methodology for screening and evaluating the soil cores for sampling are located in the main text of the RAWP in section 8.1.3.1.

Where, when, and how should the data be collected/generated?

See RAWP, Section 8.1.

Who will collect and generate the data?

A sample team of individuals who are properly trained and skilled in the execution of screening and sampling procedures will collect samples and perform the field screening measurements.

How will the data be reported?

Field data (including the field PID measurements) will be recorded on COC forms, in field logbooks, and field data sheets. The fixed-laboratory will provide data in an electronic data deliverable (EDD). Project data following verification, assessment and validation will be placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS).

How will the data be archived?

Electronic data will be archived in OREIS. Hard copy data will be submitted to the Document Management Center.

QAPP Worksheet #12-A
Measurement Performance Criteria Table[1]

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Aqueous Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Aqueous Precision RPD	Soil/ Sediment PQL (µg/kg)	Soil/ Sediment MDL* (µg/kg)	Water PQL (µg/L)	Water MDL* (µg/L)
Volatile Organic Compounds										
1,1-Dichloroethene	75-35-4	SW-846, 8260	50-150	80-120	< 22/< 50	< 25	10	5	5	2.5
cis-1,2-Dichloroethene	156-59-2	SW-846, 8260	50-150	70-125	< 22/< 50	< 25	10	5	1	0.5
trans-1,2-Dichloroethene	156-60-5	SW-846, 8260	50-150	70-125	<22/< 50	< 25	10	5	1	0.5
Trichloroethene	79-01-6	SW-846, 8260	50-150	70-125	< 22/< 50	≤ 25	10	5	1	0.5
Vinyl Chloride	75-01-4	SW-846, 8260	50-150	50-145	< 22/< 50	≤ 25	10	5	2	1

[1] Additional information about quality control samples is found in Worksheet #28.
* The analytical laboratory may not be able to meet the no action levels (NALs) established by Methods for Conducting Risk Assessments and Risk Evaluations at PGDP (Risk Methods Document DOE 2011). In those cases, LATA Kentucky will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit. NALs are listed in Worksheet #15.

QAPP Worksheet #12-B
Measurement Performance Criteria Table

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Soil/ Sediment PQL (µg/kg)	Soil/ Sediment MDL* (µg/kg)
Semivolatile Organic Compounds						
Acenapthene	83-32-9	8270	50-150	30	660	330
Acenaphthylene	208-96-8	8270	50-150	30	660	330
Anthracene	120-12-7	8270	50-150	30	660	330
Benzo(a)anthracene	56-55-3	8270	50-150	30	660	330
Benzo(b)fluoranthene	205-99-2	8270	50-150	30	660	330
Benzo(k)fluoranthene	207-08-9	8270	50-150	30	660	330
Benzo(a)pyrene	50-32-8	8270	50-150	30	660	330
Benzo(g,h,i)perylene	191-24-2	8270	50-150	30	660	330
bis(2-Chloroisoproply)-ether	108-60-1	8270	50-150	30	660	330
bis(2-Chloroethoxy) methane	111-91-1	8270	50-150	30	660	330
bis(2-Chlororethyl)ether	111-44-4	8270	50-150	30	660	330
bis(2-Ethylhexyl) phthalate	117-81-7	8270	50-150	30	660	330
4-Bromophenyl-phenyl ether	101-55-3	8270	50-150	30	660	330
Butylbenzylphthalate	85-68-7	8270	50-150	30	660	330
2-Chloronaphthalene	91-58-7	8270	50-150	30	660	330

QAPP Worksheet #12-B (Continued)
Measurement Performance Criteria Table

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Soil/ Sediment PQL (µg/kg)	Soil/ Sediment MDL* (µg/kg)
Semivolatile Organic Compounds						
2-Chlorophenol	95-57-8	8270	50-150	30	660	330
di-N-butylphthalate	84-74-2	8270	50-150	30	660	330
di-N-octylphthalate	117-84-0	8270	50-150	30	660	330
Dibenzo(a,h)anthracene	53-70-3	8270	50-150	30	660	330
Dibenzofuran	132-64-9	8270	50-150	30	660	330
1,2-Dichlorobenzene	95-50-1	8270	50-150	30	660	330
1,3- Dichlorobenzene	541-73-1	8270	50-150	30	660	330
1,4- Dichlorobenzene	106-46-7	8270	50-150	30	660	330
2,4-Dichlorophenol	120-83-2	8270	50-150	30	660	330
Diethylphthalate	84-66-2	8270	50-150	30	660	330
2,4-Dimethylphenol	105-67-9	8270	50-150	30	660	330
Dimethylphthalate	131-11-3	8270	50-150	30	660	330
2,4-Dinitrotoluene	121-14-2	8270	50-150	30	660	330
2,6-Dinitrotoluene	606-20-2	8270	50-150	30	660	330
Fluoranthene	206-44-0	8270	50-150	30	660	330
Fluorene	86-73-7	8270	50-150	30	660	330
Hexachlorobenzene	118-74-1	8270	50-150	30	660	330

QAPP Worksheet #12-B (Continued)
Measurement Performance Criteria Table

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Soil/ Sediment PQL (µg/kg)	Soil/ Sediment MDL* (µg/kg)
Semivolatile Organic Compounds						
Hexachlorobutadiene	87-68-3	8270	50-150	30	660	330
Hexachlorocyclo-pentadiene	77-47-4	8270	50-150	30	660	330
Hexachloroethane	67-72-1	8270	50-150	30	660	330
Indeno(1,2,3-cd)pyrene	193-39-5	8270	50-150	30	660	330
Isophorone	78-59-1	8270	50-150	30	660	330
2-Methylnaphthalene	91-57-6	8270	50-150	30	660	330
2-Methylphenol (o-cresol)	95-48-7	8270	50-150	30	660	330
4-Methylphenol (p-cresol)	106-44-5	8270	50-150	30	660	330
Naphthalene	91-20-3	8270	50-150	30	660	330
Nitrobenzene	98-95-3	8270	50-150	30	660	330
2-Nitrophenol	88-75-5	8270	50-150	30	660	330
N-Nitroso-di-n-dipropylamine	621-64-7	8270	50-150	30	660	330
Phenanthrene	85-01-8	8270	50-150	30	660	330
Phenol	108-95-2	8270	50-150	30	660	330
Pyrene	129-00-0	8270	50-150	30	660	330

QAPP Worksheet #12-B (Continued)
Measurement Performance Criteria Table

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Soil/ Sediment PQL (µg/kg)	Soil/ Sediment MDL* (µg/kg)
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	120-82-1	8270	50-150	30	660	330
2,4,5-Trichlorophenol	95-95-4	8270	50-150	30	660	330
2,4,6-Trichlorophenol	88-06-2	8270	50-150	30	660	330
4-Chlorophenyl-phenyl ether	7005-72-3	8270	50-150	30	660	330
Chrysene	218-01-9	8270	50-150	30	660	330
Benzyl alcohol	100-51-6	8270	50-150	30	660	330
4-Chloro-3-methylphenol	59-50-7	8270	50-150	30	660	330
4-Chloroaniline	106-47-8	8270	50-150	30	660	330
3,3-Dichlorobenzidine	91-94-1	8270	50-150	30	660	330
Benzoic acid	65-85-0	8270	50-150	30	660	330
4,6-Dinitro-2-methylphenol	534-52-1	8270	50-150	30	660	330
2,4-Dinitrophenol	51-28-5	8270	50-150	30	660	330
2-nitroaniline	88-74-4	8270	50-150	30	660	330
3-nitroaniline	99-09-2	8270	50-150	30	660	330
4-nitroaniline	100-01-6	8270	50-150	30	660	330
4-Nitrophenol	100-02-7	8270	50-150	30	660	330
Pentachlorophenol	87-86-5	8270	50-150	30	660	330

* The analytical laboratory may not be able to meet the no action levels (NALs) established by Methods for Conducting Risk Assessments and Risk Evaluations at PGDP (Risk Methods Document) (DOE 2011). In those cases, LATA Kentucky will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit. NALs are listed in Worksheet #15.

QAPP Worksheet #12-C
Measurement Performance Criteria Table

Analyte	CAS Number	EPA Method	Soil/Sediment Accuracy % Recovery	Soil/ Sediment Precision RPD Lab/Field	Soil/ Sediment PQL (mg/kg)	Soil/ Sediment MDL* (mg/kg)
Polychlorinated Biphenyls						
Aroclor-1016	12674-11-2	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1221	11104-28-2	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1232	11141-16-5	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1242	53469-21-9	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1248	12672-29-6	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1254	11097-69-1	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1260	11096-82-5	608/8082	60-130	≤ 43	0.13	0.065
Aroclor-1268	11100-14-4	608/8082	60-130	≤ 43	0.13	0.065

* The analytical laboratory may not be able to meet the no action levels (NALs) established by Methods for Conducting Risk Assessments and Risk Evaluations at PGDP (Risk Methods Document) (DOE 2011). In those cases, LATA Kentucky will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit. NALs are listed in Worksheet #15.

CAS = Chemical Abstracts Service
EPA = U.S. Environmental Protection Agency
MDL = method detection limit
PQL = practical quantitation limit
RPD = relative percent difference

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
OREIS Database	Various	Various	Data will be used to optimize remedy selection and support remedial design.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.
Historical Documentation	WAG 6 RI Report (DOE/OR/07-1727&D2)	DOE contractors, soil and water analyses, 1997	Information will be used in conjunction with newly collected data to help assess the initial mass of VOCs present in the southeast C-400 block.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used. VOC levels may have significantly declined since collection of the samples.
Historical Documentation	2008 C-400 IRA Remedial Design Report (DOE/LX/07-0005&D2/R1)	DOE contractors, MIP logs, 2005	Information will be used in conjunction with newly collected data to help assess the initial mass of VOCs present in the southeast C-400 block.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used. Twinned MIP logs of 2005 and 2010 cannot be reliably correlated.

QAPP Worksheet #13 (Continued)
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Historical Documentation	Attachment A2 of Appendix of the C-400 Revised Proposed Plan (DOE/LX/07-1263&D1)	DOE contractors, soil and water analyses and MIP logs, 2010	Information will be used in conjunction with newly collected data to help assess the initial mass of VOCs present in the southeast C-400 block.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used. MIP logs of 2010 could not be reliably correlated with analytical data of twinned soil borings.

QAPP Worksheet #14
Summary of Project Tasks*

Sampling Tasks:

Collect samples, prepare blanks, preserve samples, document field notes, complete COC, label samples, package/ship samples per standard operating procedures Worksheet #21.

Analysis Tasks:

Receive samples, complete COC, extract samples, analyze extract, review data, report data per standard methods Worksheet #21.

Quality Control Tasks:

QC will be per QAPP worksheets as follows:

- QC samples—Worksheets #20 and #28
- Equipment calibration—Worksheets #22 and #24
- Data review/validation—Worksheets #34, #35, #36, and #37

Secondary Data:

See Worksheet #13.

Data Management Tasks:

Data management will be per procedure PAD-ENM-5007, *Data Management Coordination*, and the Data Management and Implementation Plan, Section 10 found in the C-400 RAWP, (DOE/LX/07-1271&D2).

Documentation and Records:

Documentation and records will be per procedure PAD-RM-1009, *Records Management, Administrative Records, and Document Control.*

Assessment/Audit Tasks:

Assessments and audits will be per procedure PAD-QA-1420, *Conduct of Management Assessments.*

Prior to mobilization to perform fieldwork, an independent assessment (Internal Field Readiness Review) will be conducted to determine if the project is prepared to proceed (e.g., scope has been defined and is understood by workforce, scope has regulatory approval, scope properly contracts, personnel properly training to complete). One management assessment will be performed during initial sampling of the ERH network to verify work is being performed consistent with the SAP.

Data Review Tasks:

Data review tasks will be per procedure PAD-ENM-5003, *Quality Assured Data.*

* It is understood that SOPs are contractor specific.

QAPP Worksheet #15-A
Reference Limits and Evaluation Table

Matrix: Soil
Analyte Group: Volatile Organic Compounds

Volatile Organic Compounds	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/kg)	MDLs (µg/kg)
1,1-Dichloroethene	75-35-4	23.7	NAL	Yes	10	5
cis-1,2-Dichloroethene	156-59-2	1,050	NAL	Yes	10	5
trans-1,2-Dichloroethene	156-60-5	14,200	NAL	Yes	10	5
Trichloroethene	79-01-6	23.4	NAL	Yes	10	5
Vinyl chloride	75-01-4	82.4	NAL	Yes	10	5

[a] NALs are listed for all the chemicals of potential concern (COPCs).
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #15-B
Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: Volatile Organic Compounds

Volatile Organic Compounds	CAS Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?	Laboratory-Specific[b]	
					PQLs (µg/L)	MDLs (µg/L)
1,1-Dichloroethene	75-35-4	7	MCL	Yes	5	2.5
cis-1,2-Dichloroethene	156-59-2	70	MCL	Yes	1	0.5
trans-1,2-Dichloroethene	156-60-5	100	MCL	Yes	1	0.5
Trichloroethene	79-01-6	5	MCL	Yes	1	0.5
Vinyl Chloride	75-01-4	2	MCL	Yes	2	1

[a] Project Action Limits shown are maximum contaminant levels (MCLs) as established by the National Primary Drinking Water Regulations.
[b] The analytical laboratory may not be able to meet the Project Action Limits. In those cases, LATA Kentucky will have the laboratory report to the method detection limit qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit.

QAPP Worksheet #15-C
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Semivolatile Organic Compounds

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/kg)	MDLs (µg/kg)
Acenapthene	83-32-9	117,000	NAL	Yes	660	330
Acenaphthylene	208-96-8	Not calculated	NAL	Yes	660	330
Anthracene	120-12-7	747,000	NAL	Yes	660	330
Benzo(a)anthracene	56-55-3	196	NAL	Yes	660	330
Benzo(b)fluoranthene	205-99-2	197	NAL	Yes	660	330
Benzo(k)fluoranthene	207-08-9	1,960	NAL	Yes	660	330
Benzo(a)pyrene	50-32-8	19.7	NAL	Yes	660	330
Benzo(g,h,i)perylene	191-24-2	Not calculated	None	No	660	330
bis(2-Chloroisoproply)ether	108-60-1	Not calculated	None	No	660	330
bis(2-Chloroethoxy) methane	111-91-1	Not calculated	None	No	660	330
bis(2-Chlororethyl)ether	111-44-4	Not calculated	None	No	660	330
bis(2-Ethylhexyl) phthalate	117-81-7	Not calculated	None	No	660	330
4-Bromophenyl-phenyl ether	101-55-3	Not calculated	None	No	660	330
Butylbenzylphthalate	85-68-7	Not calculated	None	No	660	330
2-Chloronaphthalene	91-58-7	Not calculated	None	No	660	330
2-Chlorophenol	95-57-8	Not calculated	None	No	660	330

QAPP Worksheet #15-C (Continued)
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Semivolatile Organic Compounds

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/kg)	MDLs (µg/kg)
di-N-butylphthalate	84-74-2	Not calculated	None	No	660	330
di-N-octylphthalate	117-84-0	Not calculated	None	No	660	330
Dibenzo(a,h)anthracene	53-70-3	Not calculated	None	No	660	330
Dibenzofuran	132-64-9	Not calculated	None	No	660	330
1,2-Dichlorobenzene	95-50-1	Not calculated	None	No	660	330
1,3- Dichlorobenzene	541-73-1	Not calculated	None	No	660	330
1,4- Dichlorobenzene	106-46-7	Not calculated	None	No	660	330
2,4-Dichlorophenol	120-83-2	Not calculated	None	No	660	330
Diethylphthalate	84-66-2	Not calculated	None	No	660	330
2,4-Dimethylphenol	105-67-9	Not calculated	None	No	660	330
Dimethylphthalate	131-11-3	Not calculated	None	No	660	330
2,4-Dinitrotoluene	121-14-2	Not calculated	None	No	660	330
2,6-Dinitrotoluene	606-20-2	Not calculated	None	No	660	330
Fluoranthene	206-44-0	109,000	NAL	Yes	660	330
Fluorene	86-73-7	91,500	NAL	Yes	660	330
Hexachlorobenzene	118-74-1	49.2	NAL	Yes	660	330

QAPP Worksheet #15-C (Continued)
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Semivolatile Organic Compounds

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/kg)	MDLs (µg/kg)
Hexachlorobutadiene	87-68-3	Not calculated	None	No	660	330
Hexachlorocyclo-pentadiene	77-47-4	Not calculated	None	No	660	330
Hexachloroethane	67-72-1	Not calculated	None	No	660	330
Indeno(1,2,3-cd)pyrene	193-39-5	197	NAL	Yes	660	330
Isophorone	78-59-1	Not calculated	None	No	660	330
2-Methylnaphthalene	91-57-6	Not calculated	None	No	660	330
2-Methylphenol (o-cresol)	95-48-7	Not calculated	None	No	660	330
4-Methylphenol (p-cresol)	106-44-5	Not calculated	None	No	660	330
Naphthalene	91-20-3	1,150	NAL	Yes	660	330
Nitrobenzene	98-95-3	Not calculated	None	No	660	330
2-Nitrophenol	88-75-5	Not calculated	None	No	660	330
N-Nitroso-di-n-dipropylamine	621-64-7	18.9	NAL	Yes	660	330
Phenanthrene	85-01-8	Not calculated	NAL	Yes	660	330
Phenol	108-95-2	Not calculated	None	No	660	330
Pyrene	129-00-0	81,200	NAL	Yes	660	330

QAPP Worksheet #15-C (Continued)
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Semivolatile Organic Compounds

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/kg)	MDLs (µg/kg)
1,2,4-Trichlorobenzene	120-82-1	Not calculated	None	No	660	330
2,4,5-Trichlorophenol	95-95-4	Not calculated	None	No	660	330
2,4,6-Trichlorophenol	88-06-2	Not calculated	None	No	660	330
4-Chlorophenyl-phenyl ether	7005-72-3	Not calculated	None	No	660	330
Chrysene	218-01-9	19,000	NAL	No	660	330
Benzyl alcohol	100-51-6	Not calculated	None	No	660	330
4-Chloro-3-methylphenol	59-50-7	Not calculated	None	No	660	330
4-Chloroaniline	106-47-8	Not calculated	None	No	660	330
3,3-Dichlorobenzidine	91-94-1	Not calculated	None	No	660	330
Benzoic acid	65-85-0	Not calculated	None	No	660	330
4,6-Dinitro-2-methylphenol	534-52-1	Not calculated	None	No	660	330
2,4-Dinitrophenol	51-28-5	Not calculated	None	No	660	330
2-nitroaniline	88-74-4	296	NAL	Yes	660	330
3-nitroaniline	99-09-2	Not calculated	None	No	660	330
4-nitroaniline	100-01-6	Not calculated	None	No	660	330
4-nitrophenol	100-02-7	Not calculated	None	No	660	330
Pentachlorophenol	87-86-5	Not calculated	None	No	660	330

[a] NALs are listed for all the COPCs.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #15-D
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Polychlorinated Biphenyls

Polychlorinated Biphenyls	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (mg/kg)	MDLs (mg/kg)
Aroclor-1016	12674-11-2	0.0633	NAL	Yes	0.13	0.065
Aroclor-1221	11104-28-2	0.0437	NAL	Yes	0.13	0.065
Aroclor-1232	11141-16-5	0.0437	NAL	Yes	0.13	0.065
Aroclor-1242	53469-21-9	0.0644	NAL	Yes	0.13	0.065
Aroclor-1248	12672-29-6	0.0682	NAL	Yes	0.13	0.065
Aroclor-1254	11097-69-1	0.0501	NAL	Yes	0.13	0.065
Aroclor-1260	11096-82-5	0.0662	NAL	Yes	0.13	0.065
Aroclor-1268	11100-14-4	Not calculated	None	No	0.13	0.065

[a] NALs are listed for all the COPCs.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #16
Project Schedule/Timeline Table

Section 8 of the RAWP and Worksheet #17 of this QAPP describe the sampling approach to be used to characterize VOC levels within the C-400 Southeast Treatment Area. Section 6 of this RAWP provides the project planning schedule. The total duration of the preoperation field sampling period is approximately 10 months. Fixed-laboratory analyses are expected within 28 days of completion of the fieldwork.

QAPP Worksheet #17
Sampling Design and Rationale

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

  A judgmental sampling approach, with sampling from locations specified in Table 7 (Section 8.1.3.1, Soil) of the RAWP. The samples are intended to characterize VOC levels in the shallow, middle, and deep UCRS and shallow RGA.

- **Describe the sampling design and rationale in terms of which matrices will be sampled:**

  Soil borings will be sampled at predetermined locations to document pre-operation ERH VOC levels for comparison to post-operation ERH VOC levels.

  Limited groundwater sampling (conceptual) will be performed from wells, also to document pre-operation ERH VOC levels.

- **What analyses will be performed and at what method detection limits?**

  VOCs by SW-846, 8260, Semivolatile organic compounds (SVOCs) by SW-846, 8270, and polychlorinated biphenyls (PCBs) by SW-846, 8082. See Worksheet #12 for MDL.

- **Where are the sampling locations (including QC, critical, and background samples)?**

  See Section 8.1.3 of RAWP.

- **How many samples to be taken?**

  See Worksheet #18.

- **What is the sampling frequency (including seasonal considerations)?**

  Each preoperation or postoperation sample is a one-time sampling event.

QAPP Worksheet #18
Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Southeast C-400 Treatment Area	Soil	Subsurface	VOCs	Up to 1,700 mg/kg TCE	164 + 8 field duplicates	See Worksheet #21	See Section 8.1.2 of RAWP
			SVOCs	Up to 6.1 mg/kg diethyl-phthalate	68 + 3 field duplicates		
			PCBs	Up to 0.73 mg/kg PCB-1254	68 + 3 field duplicates		
	Groundwater	Subsurface	VOCs	TCE assumed 11,000 µg/L	60 + 3 (Conceptual)		

QAPP Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference[1]	Sample Volume[1]	Containers (number, size, and type)[2]	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Soil	Volatile Organic Compounds	High	624/8260B	15 g + 2 oz	3 x 5-g Encore Sampler & (1) 2-oz wide-mouth glass jar[3]	Cool to 4°C	48 hours (EnCore™ Sampler)
	Semivolatile Organic Compounds	Low	3550/8270C	8 oz	8-oz. wide-mouth glass jar	Cool to 4°C	7 days extraction/40 days analysis
	Polychlorinated Biphenyls	Medium	8082	250 g	9-oz. wide-mouth glass jar	Cool to 4°C	N/A
Groundwater	Volatile Organic Compounds	High	624/8260B	120 mL	3 x 40 mL glass VOA Vial	Cool < 4°C; HCl, pH < 2	14 days for preserved

[1] Sample * See Analytical SOP References table (Worksheet #23).
[2] Volume and container requirements will be specified by the laboratory.
[3] The 2-oz wide-mouth glass jar sample is for measurement of soil moisture.
HCl = hydrochloric acid
N/A = not applicable

QAPP Worksheet #20
Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of Matrix Spike	No. of Field Blanks	No. of Equip. Blanks	No. of PT Samples[1]	Total No. of Samples to Lab
Soil	Volatile Organic Compounds	High	624/8260B	26	5%	5%	5%	5%	N/A	228
	Semivolatile Organic Compounds	Low	3550/8270C	18	5%	5%	5%	5%	N/A	82
	Polychlorinated Biphenyls	Medium	8082	18	5%	5%	5%	5%	N/A	82
Ground-water	Volatile Organic Compounds	High	624/8260B	30	5%	5%	5%	5%	N/A	36

[1] PT samples are not required for the project.
N/A = not applicable

QAPP Worksheet #21
Project Sampling SOP References Table

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	PAD-ENM-0023, *Composite Sampling*	Contractor	N/A	N	None
2	PAD-ENM-0026, *Wet Chemistry and Misc. Analyses Data Verification and Validation*	Contractor	N/A	N	None
3	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*	Contractor	N/A	N	None
4	PAD-ENM-1003, *Developing, Implementing, and Maintaining Data Management Implement. Plans*	Contractor	N/A	N	None
5	PAD-ENM-2100, *Groundwater Level Measurement*	Contractor	Sampling	N	None
6	PAD-ENM-2101, *Groundwater Sampling*	Contractor	Sampling	Y	None
7	PAD-ENM-2300 *Collection of Soil Samples*	Contractor	Sampling	N	None
8	PAD-ENM-2303, *Borehole Logging*	Contractor	Sampling	N	None
9	PAD-ENM-2700, *Logbooks and Data Forms*	Contractor	N/A	N	None
10	PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*	Contractor	Sampling	N	None
11	PAD-ENM-2704, *Trip, Equipment, and Field Blank*	Contractor	Sampling	N	None
12	PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*	Contractor	Sampling	N	None
13	PAD-ENM-5003, *Quality Assured Data*	Contractor	N/A	N	None
14	PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*	Contractor	N/A	N	None
15	PAD-ENM-5007, *Data Management Coordination*	Contractor	N/A	N	None
16	PAD-ENR-0020, *Direct Push Technology Sampling*	Contractor	Sampling	N	None
17	PAD-ENM-5105, *ROAC1 Volatile and Semivolatile Data Verification and Validation*	Contractor	N/A	N	None
18	PAD-ENM-5107, *Inorganic Data Validation and Verification*	Contractor	N/A	N	None

[a] SOPs are posted to the LATA Kentucky intranet Web site. External FFA parties can access this site using remote access with privileges upon approval.
[b] The work will be conducted by LATA Kentucky 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 Table

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Mini RAE Photoionization Detector (PID) Toxic Gas Monitor with 10.5 eV Lamp or Similar Meter	Calibration checked at the beginning and end of the day	As needed in the field; semi-annually by the supplier	Measure known concentration of isobutylene 100 ppm (calibration gas)	Upon receipt, successful operation	Calibrate am, check pm	± 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
Electronic Water Level Meter	N/A	None	Check daily before each use	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's Specifications

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

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 Global Positioning System	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	Daily prior to use	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 PAD-ENM-2700, *Logbooks and Data Forms*.
RCT = radiological control technician

QAPP Worksheet #23
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	VOA	GC/MS	TBD	N
8270	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	SVOA	GC/MS	TBD	N
8082	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	Definitive	PPCB	GC	TBD	N

* Information will be based on laboratory used. Analysis will be by the most recent revision.
TBD = to be determined

QAPP Worksheet #24
Analytical Instrument Calibration Table

All laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program. 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. All 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.

No field test kits will be used during the course of this investigation.

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
GC-MS	Replace/clean ion source; clean injector, replace injector liner, replace/clip capillary column, flush/replace tubing on purge and trap; replace trap	QC standards	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
GC	ECD/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
pH meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value	Repeat maintenance activity or remove from service	Laboratory Manager	Manufacturer's specifications

* The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited annually by DOE Consolidated Audit Program (DOECAP). Laboratory(s) contracted will be DOECAP audited. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.
ECD = electron capture detector
FID = flame ionization detector
GC = gas chromatograph
MS = mass spectrometer

QAPP Worksheet #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	Sampling Teams/DOE Prime Contractor and Subcontractors
Sample Packaging (Personnel/Organization):	Sampling Teams/DOE Prime Contractor and Subcontractors
Coordination of Shipment (Personnel/Organization):	Lab Coordinator/DOE Prime Contractor
Type of Shipment/Carrier:	Direct Delivery or Overnight/Federal Express
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Custody and Storage (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Preparation (Personnel/Organization):	Analysts/Contracted Laboratory
Sample Determinative Analysis (Personnel/Organization):	Analysts/Contracted Laboratory
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	The laboratory statement of work stipulates the period for which the fixed-laboratory archives samples.
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	Archived until the laboratory has reviewed and approved the data.
Biological Sample Storage (No. of days from sample collection):	N/A
SAMPLE DISPOSAL	
Personnel/Organization:	Waste Disposition/DOE Prime Contractor and Subcontractors
Number of Days from Analysis:	6 months

QAPP Worksheet #27
Sample Custody Requirements*

COC procedures are comprised of maintaining sample custody and documentation of samples for evidence. To document COC, an accurate record of samples must be maintained in order to trace the possession of each sample from the time of collection to its introduction to the laboratory.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Not applicable.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and the courier personnel relinquishing them will be completed in the appropriate spaces on the COC record, unless the courier is a commercial carrier. This will complete the sample transfer. It will be every laboratory's responsibility to maintain internal logbooks and records that provide custody throughout sample preparation and analysis process.

Sample Identification Procedures:

Sample identification requirements will be specified in work package documents and will comply with the Data Management Implementation Plan included in the RAWP.

Chain-of-custody Procedures:

COC requirements will be per DOE Prime Contractor procedures, PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance.*

* It is understood that SOPs are contractor specific.

QAPP Worksheet #28
QC Samples Table

Matrix:	Soils, Aqueous
Analytical Group/Concentration Level:	Soils: VOCs, SVOCs, PCBs Aqueous: VOCs
Sampling SOP:	See Worksheet #21
Analytical Method/SOP Reference:	624/8260/, 3550/8270, 608/8082
Sampler's Name/Field Sampling Organization:	TBD
Analytical Organization:	TBD
No. of Sample Locations	See Section 8 of the RAWP

QC Sample:	**Frequency/ Number**[1]	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Split Samples	As requested by regulatory agency	N/A	N/A	N/A	N/A	N/A
Field Blank	Minimum 5%	≤ CRQL	Verify results; reanalyze	Laboratory should alert project	Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Trip Blank	1 per cooler containing VOC samples	≤ CRQL	Verify results; reanalyze		Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Equipment Blank	Minimum 5%	≤ CRQL	Verify results; reanalyze		Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*

QAPP Worksheet #28 (Continued)
QC Samples Table

QC Sample	Frequency/Number[1]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Internal standards, laboratory spiked blanks or spiked field samples	All samples and standards	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure PAD-ENM-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils; RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure PAD-ENM-5003, *Quality Assured Data*

[1] The number of QC samples is listed on Worksheet #20.
CRQL = contract-required quantitation limit
RPD = relative percent difference

QAPP Worksheet #29
Project Documents and Records Table

All project data and information must be documented in a format that is usable by project personnel. The QAPP describes how project data and information shall be documented, tracked, and managed from generation in the field to final use and storage in a manner that ensures data integrity, defensibility, and retrieval.

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records*
Data logbooks and associated completed sampling forms; sample COCs	Laboratory data packages, OREIS database, and associated data packages	OREIS database and associated data packages	PAD-ENM-5003, Att. G, Data Assessment Review Checklist and Comment Form

* It is understood that SOPs are contractor specific.
OREIS = Oak Ridge Environmental Information System

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/ Organization (Name and Address, Contact Person and Telephone Number)[1]	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)[1]
Soil	Volatile Organic Compounds	High	Southeast C-400 Treatment Area, For ID Numbers, see Table 7 of RAWP	8260	28-day	TBD	TBD
	Semivolatile Organic Compounds	Low		8270	28-day	TBD	TBD
	Polychlorinated Biphenyls	Medium		8082	28-day	TBD	TBD
Ground-water	Volatile Organic Compounds	High	Southeast C-400 Treatment Area (Conceptual)	8260	28-day	TBD	TBD

TBD = to be determined
[1] Laboratory contracting will be subsequent to the completion of the RAWP.

QAPP Worksheet #31
Planned Project Assessments Table

LATA Kentucky will ensure that protocol outlined in the QAPP is implemented adequately. Assessment activities help to ensure that the resultant data quality is adequate for its intended use and that appropriate responses are in place to address nonconformances and deviations from the QAPP. The following is a list of assessments project teams may use.

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Audit/ Surveillance	A	Internal	Prime Contractor QA	QA Specialists or Contractor	Project Management, Contractor	Project Management, Contractor	QA Specialist, Contractor
Laboratory Audit	B	External	DOE Consolidated Audit Program (DOECAP)	Laboratory Assessor	Laboratory	Laboratory	DOECAP
Management Assessments	Annual	Internal	Prime Contractor Project Management	Regulatory Management, Contractor	Regulatory Management, Contractor	Regulatory Management, Contractor	QA Specialist, Contractor
Management by Walking Around (MBWA)*	Quarterly	Internal	Project Management	Project Management	Project Management	Project Management	Project Management
MBWA Follow-up surveillances	Quarterly	Internal	Project Management	Project Management or designee, Contractor	Project Management/Designee, Contractor	Project Management, Contractor	Project Management

A = Frequency determined by QA Manager and conducted per PAD-QA-1003, *Surveillance* or PAD-QA-1502, *Audits*.
B = Assessment frequency determined by regulatory manager and conducted per PAD-QA-1420, *Conduct of Management Assessments*.
* Reference: PAD-QA-1033 *Management by Walking Around (MBWA) Program*.

QAPP Worksheet #32
Assessment Findings and Corrective Action Responses*

Field modifications to procedures in the QAPP must be approved before the modifications are implemented and then documented. The process controlling procedure modification is PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents*. Field modifications are documented through the work control process per PAD-WC-0021. Corrective action in the field may be necessary when the sampling design is changed. For example, a change in the field may include increasing the number or type of samples or analyses, changing sampling locations, and/or modifying sampling protocol. When this occurs, the project team shall identify any suspected technical or QA deficiencies and note them in the field logbook. Worksheet #32 details how project teams will address assessment findings.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Time frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization)	Time Frame for Response
Management	QA-F-0074, Management Assessment Report and Checklist, and QA-F-0710, Issue Identification Form	Project management, issue owner, contractor	Upon issuance of QA-F-0074, Management Assessment Report and Checklist, the QA-F-0710, Issue Identification Form, will be completed and attached to the assessment report	QA-F-0710, Issue Identification Form, documents the issue response and/or corrective actions	Action owner as designated by issue owner, contractor	Fifteen days for initial issue response; corrective action schedule determined by issue owner, per PAD-QA-1210
Audit, and Surveillances	QA-F-0069, Audit Checklist, or QA-F-0072, Surveillance Report, and QA-F-0075, Nonconformance Report (NCR) Form or QA-F-0068, Condition Report (CR) Form	Project management, issue owner, contractor	Upon issuance of QA-F-0069, Audit Checklist, or QA-F-0072, Surveillance Report, the QA-F-0075, Nonconformance Report (NCR) Form or QA-F-0068, Condition Report (CR) Form, will be completed and attached to the report	QA-F-0075, Nonconformance Report (NCR) Form or QA-F-0068, Condition Report (CR) Form, documents the issue response and/or corrective actions	Action owner as designated by issue owner, contractor	Fifteen days for initial issue response; corrective action schedule determined by issue owner, per PAD-QA-1210

* It is understood that SOPs are contractor specific.

QAPP Worksheet #33
QA Management Reports Table

Reports to management include project status reports, field and/or laboratory audits, and data quality assessments. These reports will be directed to the QA Manager and Project Manager who have ultimate responsibility for assuring that any CA response is completed, verified, and documented.

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Change Requests	As needed	Ongoing	Field staff	QAPP recipients
QAPP Addenda	As needed	Not Applicable	Project Manager	QAPP recipients
Audits/Surveillances	TBD as determined by QA Manager	30 days after completion of audit/surveillance	QA Manager	LATA Kentucky Project Manager QA Manager
Corrective Action Plan	As needed	Varies per PAD-QA-1210, *Issues Management*	Project Manager	QA Manager

QAPP Worksheet #34
Verification (Step I) Process Table

This section of the QAPP provides a description of the QA activities that will occur after the data collection phase of the project is completed. Implementation of this section will determine whether the data conforms to the specified criteria satisfying the project objectives.

Verification Input	Description*	Internal/ External	Responsible for Verification (Name, Organization)
Field Logbooks	Field logbooks are verified per LATA Kentucky procedure, PAD-ENM-2700, *Logbooks and Data Forms*, and PAD-ENM-5003, *Quality Assured Data*.	Internal	Project Management or designee, Contractor
Chains-of-custody	Chains-of-custody are controlled by LATA Kentucky procedure, PAD-ENM-5004, *Sample Tracking, Lab Coordination and Sample Handling Guidance*. COCs will be included in data assessment packages for review as part of data verification and data assessment.	Internal	Sample and Data Management, Project Management, and QA Personnel, Contractor
Field and Laboratory Data	Field and analytical data are verified and assessed per LATA Kentucky procedure, PAD-ENM-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. The data assessment packages will include field and analytical data, COCs, 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 data met the data quality objectives of the project.	Internal	Sample and Data Management, Project Management, and QA Personnel**, Contractor
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change requests, and field logbooks.	Internal	Sample and Data Management, Project Management, and QA Personnel**, Contractor
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to LATA Kentucky. Subsequently, LATA Kentucky will evaluate the data packages for completeness and compliance.	External/ Internal	Laboratory Manager, LATA Kentucky Sample and Data Management
Electronic Data Deliverables	Determine whether required fields and format were provided.	Internal	Sample and Data Management
QAPP	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

* It is understood that SOPs are contractor specific.
** QA specialist performs general QA review.

QAPP Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description*	Responsible for Validation (Name, Organization)
IIa	Data Deliverables, Analytes, and Holding Times	The documentation from the contractual screening will be included in the data assessment packages, per LATA Kentucky procedure, PAD-ENM-5003, *Quality Assured Data*.	Sample and Data Management Personnel, Contractor
IIa	COC, Sample Handling, Sampling Methods and Procedures, and Field Transcription	These items will be validated during the data assessment process as required by LATA Kentucky procedure, PAD-ENM-5003, *Quality Assured Data*. The documentation of this validation will be included in the data assessment packages.	Sample and Data Management Personnel, Contractor
IIa	Analytical Methods and Procedures, Laboratory Data Qualifiers, and Standards	These items will be reviewed during the data validation process as required by LATA Kentucky 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 Sample and Data Management, Project, Contractor
IIa	Audits	The audit reports and accreditation and certification records for the laboratory supporting the projects will be considered in the bidding process.	QA Personnel
IIb	Deviations and qualifiers from Step IIa	Any deviations and qualifiers resulting from Step IIa process will be documented in the data assessment packages.	Sample and Data Management, Project, and QA Personnel, Contractor
IIb	Sampling Plan, Sampling Procedures, Co-located Field Duplicates, Project Quantitation Limits, Confirmatory Analyses, Performance Criteria	These items will be evaluated as part of the data verification and data assessment process per LATA Kentucky procedure, PAD-ENM-5003, *Quality Assured Data*. These items will be considered when evaluating whether the project met the DQOs.	Sample and Data Management, Project, and QA Personnel, Contractor

* It is understood that SOPs are contractor specific.

QAPP Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
Step IIa/IIb	Soil	VOCs	High	National Functional Guidelines; Worksheets #12, #15, and #28; and PAD-ENM-0026, PAD-ENM-0811, PAD-ENM-5003, PAD-ENM-5103, and PAD-ENM-5105	Data Validator*
		SVOCs	Low		
		PCBs	Medium		
	Groundwater	VOCs	High		

* 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 LATA Kentucky who is not involved in the project.

QAPP Worksheet #37
Usability Assessment*

LATA Kentucky shall determine the adequacy of data based on the results of validation and verification. The usability step involves assessing whether the process execution and resulting data meet project quality objectives documented in the QAPP.

Summarize the usability assessment process and all 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 PAD-ENM-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 data quality objectives of the project were met. For data selected for validation, the following procedures are used: PAD-ENM-0026, PAD-ENM-0811, PAD-ENM-5102, PAD-ENM-5105, and PAD-ENM-5107.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

PARCCS parameters (precision, accuracy, representativeness, comparability, completeness, and sensitivity) will be evaluated per procedure, PAD-ENM-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

Identify the personnel responsible for performing the usability assessment:

Project and QA personnel.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

Data assessment packages will be created, which will include data assessment comments/questions and laboratory comments. Data verification and assessment queries indicating any historical outliers and background soil exceedances also will be included in the data assessment packages.

* It is understood that SOPs are contractor specific.

APPENDIX C

AIR DISPERSION ANALYSIS

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C.1 AIR DISPERSION ANALYSIS

C.1.1 INTRODUCTION

This appendix describes the air dispersion analysis of potential hazardous air pollutant emissions from the implementation of the C-400 Interim Remedial Action (IRA). Based on lessons learned from Phase I, the sensitivity of property boundary concentrations to various vapor flow rate has been included in this analysis. Also, the sensitivity of the boundary concentrations to exhaust concentrations was analyzed. The property boundary concentrations for these potential hazardous air pollutant (HAP) emissions were estimated utilizing using BREEZE AERMOD GIS Pro v5.1.7. Report printouts and electronic model-ready input files are included in the attachment to this appendix. The results of the dispersion analysis are summarized in Section 11 of the Remedial Action Work Plan.

C.1.2 IDENTIFICATION OF TOXIC POLLUTANTS

The potential HAPs that could be emitted by the C-400 IRA have been identified based on groundwater characterization. The groundwater characterization is documented in *Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2211&D2. The potential HAPs that could be emitted are trichloroethene (TCE), vinyl chloride, *trans*-1,2-dichloroethene (DCE), *cis*-1,2-DCE, and 1,1-DCE. These hazardous air pollutants will be removed from the subsurface using electrical resistance heating (ERH). ERH involves *in situ* heating of soils resulting in the collection and recovery of contaminants from the aquifer and vadose zone.

C.1.3. ALLOWABLE OFF-SITE CONCENTRATIONS CALCULATIONS

The treated vapor/gases must comply with the contaminant concentration requirements of 401 *KAR* 63:020. This states that no owner or operator shall allow any affected facility to emit potentially hazardous matter or toxic substances in such quantities or duration as to be harmful to the health and welfare of humans, animals and plants.

C.1.3.1 TCE and Vinyl Chloride Allowable Off-site Concentrations

The concentrations of TCE and vinyl chloride are based on the EAP Air Toxics Risk Assessment Reference Library, Volume 2, Facility Specific Assessment. These values are located at the following Web site http://www.epa.gov/ttn/atw/toxsource/table1.pdf. Both TCE and vinyl chloride are possible carcinogens. The cancer chronic inhalation value for each is used in calculating the maximum allowable concentration. The value for TCE is 0.000002 per $\mu g/m^3$ and the value for vinyl chloride is 0.0000088 per $\mu g/m^3$. The allowable risk is assumed to be 1×10^{-6}. The maximum allowable concentration is calculated by the following formula:

Allowable Risk = Estimate of continuous inhalation exposure X Inhalation Unit Risk Estimate

Or

Estimate of continuous inhalation exposure = Allowable Risk/Inhalation Unit Risk Estimate

For TCE the calculation would be as follows:

TCE Allowable concentration = 1 x 10^{-6}/0.000002 per µg/m^3

TCE Allowable concentration = 0.5 µg/m^3

Similarly for vinyl chloride the allowable concentration would be 0.11 µg/m^3

C.1.3.2 DCE Allowable Off-site Concentrations

The maximum allowable air concentrations for dichloroethene were calculated using the U.S. Environmental Protection Agency (EPA) Regions 9 Preliminary Remediation Goals (PRG) values, which are available at http://www.epa.gov/region09/waste/sfund/prg. These values are based on the noncancer risks posed by long-term exposure to DCE. The health effects of exposure to DCE are measured by a hazardous index, with a hazard index of 1 being an indication of the nearest off-site receptor having detrimental health effects from exposure to that chemical.

DCE is present in three chemical forms, 1,1-DCE; *cis*-1,2-DCE, and *trans*-1.2-DCE. The ambient air PRG for each chemical form is 1,1-DCE—210 µg/m^3; *cis*-1,2-DCE—37 µg/m^3; and *trans*-1,2-DCE—73 µg/m^3.

All of the allowable off-site concentrations are shown in Table C.1.

Table C.1. Allowable Off-site Concentration Limits

Pollutant	Allowable Off-site Concentration (µg/m^3)	Reference Source
TCE	0.5	EAP Air Toxics Risk Assessment Reference Library, Volume 2, Facility Specific Assessment
vinyl chloride	0.11	EAP Air Toxics Risk Assessment Reference Library, Volume 2, Facility Specific Assessment
1,1-DCE	210	Preliminary Remediation Goals
cis-1,2-DCE	37	Preliminary Remediation Goals
trans-1,2-DCE	73	Preliminary Remediation Goals

C.1.4 ESTIMATED EMISSION RATES

C.1.4.1 Construction Fugitive Emissions

During construction of the ERH, fugitive emissions will be released. The fugitive emissions occur when the subsurface equipment, such as electrodes and well completion components, is placed in the boreholes and displace the contaminate-laden air.

Assuming the average depth to of each borehole is 85 ft and the average borehole diameter is 9 inches, the volume of a borehole is 37.6 ft^3. Fugitive emission calculations were based on 220 boreholes; however, the actual number of boreholes for Phase IIa will be fewer. Assume all boreholes will be filled over 8 months.

The estimated contaminant fractions of the displaced air are based on the characterization of the groundwater contamination. The assumed contaminants occupy the entire volume and are present at the following fractions: TCE—0.395; vinyl chloride—0.047; 1,1-DCE—0.055; *cis*-1,2-DCE—0.079; *trans*-1,2-DCE—0.432.

The estimated fugitive emission rates are shown in Table C.2.

Table C.2. Estimated Fugitive Emission Rates

Chemical	Fugitive Emission Rate
	g/s
TCE	2.5E-5
vinyl chloride	3.0E-6
1,1-DCE	3.5E-6
cis-1,2-DCE	5.1E-6
trans-1,2-DCE	2.8E-5

C.1.4.2 Operations Emissions

During operation of the project, the hazardous constituents in the subsurface will be volatilized underground and recovered by a vapor phase extraction system. The system will capture the soil vapors, which will be treated and released through a stack. The current design utilizes a steam regenerated carbon adsorption system to remove hazardous constituents from the off-gas; then an additional activated carbon filtration unit will polish the vapor prior to discharge to the atmosphere. The current design criteria for the treatment system is such that the concentrations of an individual HAP in the exhaust stack will not exceed 20 ppmv.

The flow rate through the stack will vary. Experience from Phase 1 has shown that the flow rate of the stack exhaust is based on variable speed blowers. The flow rate is varied in order to achieve the vacuum level needed to adequately draw the vapors from the soil around the wells. The flow rate can be as low as 300 scfm. Phase IIA will have an additional effluent stream exhausting through the stack. The steam generated carbon beds use air to dry and cool the activated carbon vessels after regeneration. This air stream could contain low concentrations of contaminants. This drying and cooling effluent is intermittent and varies from 500 scfm to 1,000 scfm. The stack flow rate from the combined well field and drying/cooling streams is nominal flow rate of 1,800 scfm with a maximum flow rate of 2,300 of scfm.

In order to estimate the maximum off-site concentration the exhaust was assumed to contain the maximum concentration of each HAP. The following preliminary design parameters[1] for the stack were used in the model to estimate the dispersion of the hazardous constituents:

- 8-inch diameter
- 20-ft high
- 300 to 2,300 scfm flow rate
- 70°F exhaust gas temperature

The air dispersion model input is grams per second. The stack concentration is converted from ppmv to milligrams per cubic meter using the following formula:

[1] The last paragraph of Section 4.5.3 in the *Remedial Design Report, Certified for Construction Design Drawings and Technical Specifications Package, for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0005&D2, (RDR) states, "Off-gas from the vapor-phase polishing system will be discharged to the atmosphere through a 20-ft tall by 8-inch diameter stack."

mg/m^3 = (ppmv)(molecular weight)(12.187)/(273.15+ ºC)

The maximum emission rate in grams per second is calculated based on the maximum concentration and various flow rates. g/s = (mg/m^3)(flow rate)(unit conversions)

The maximum emission rates during operation are listed in Table C.3 in both ppmv and grams per second for the bounding flow rates (300 scfm minimum, 2,300 scfm maximum) and the design flowrate (1,800 scfm).

Table C.3. Estimated Operational Emission Rates

Chemical	Stack Design Concentration			
		300 scfm	1,800 scfm	2,300 scfm
	ppmv	g/s	g/s	g/s
TCE	20	0.0154	0.0925	0.118
vinyl chloride	20	0.00733	0.0440	0.0562
1,1-DCE	20	0.0114	0.0682	0.0872
cis-1,2-DCE	20	0.0114	0.0682	0.0872
trans-1,2-DCE	20	0.0114	0.0682	0.0872

C.1.4.3 Maximum Off-site Concentrations

The property boundary ambient concentration for each HAP was estimated utilizing the air dispersion model BREEZE AERMOD GIS Pro v5.1.7.

Surface meteorology data from station number 72435 and upper air meteorology data from station 00013897 were used. Dispersion analysis of meteorological data from these stations for 2000 and 2002 through 2005 showed the highest boundary concentration occurred for 2003 data (January 1, 2003, through December 31, 2003). The dataset for 2001 was incomplete and 2000 was used as a replacement; therefore, this data was used to calculate the maximum off-site concentration. The AERMOD ready meteorological files were purchased from Trinity Consultants, Inc.

The dispersion analysis averages the concentration annually. The results of the TCE operational emissions are shown in the attached model reports. The same model parameters were run for the emission rates for all of the pollutants for both fugitive and operational emissions. The estimated maximum concentrations to a receptor at the property boundary resulting from the dispersion analysis for fugitive emissions are shown in Table C.4.

Table C.4. Estimated Off-site Concentrations for Fugitive Emissions

Chemical	Off-site Limit	Annual Average Maximum Off-site Concentration
	$\mu g/m^3$	$\mu g/m^3$
TCE	0.5	3.8E-5
vinyl chloride	0.11	4.5E-6
1,1-DCE	210	5.3E-6
cis-1,2-DCE	37	7.6E-6
trans-1,2-DCE	73	4.2E-5

The estimated maximum off-site concentrations to a receptor at the property boundary resulting from operational emissions are shown in Table C.5.

Table C.5. Estimated Off-site Concentrations for Operational Emissions

Chemical	Off-site Limit	Annual Average Maximum Off-site Concentration		
		300 scfm	1,800 scfm	2,300 scfm
	µg/m^3	µg/m^3	µg/m^3	µg/m^3
TCE	0.5	0.0117	0.0555	0.0677
vinyl chloride	0.11	0.00557	0.0264	0.0322
1,1-DCE	210	0.00864	0.0410	0.0500
cis-1,2-DCE	37	0.00864	0.0410	0.0500
trans-1,2-DCE	73	0.00864	0.0410	0.0500

The estimated concentrations are well below maximum allowable off-site concentrations. The sum hazard index for the three DCE chemical forms when combined are less than one, indicating the combination of HAPs is less than the allowable concentration.

C.1.4.4 Sensitivity to Stack Concentration

The sensitivity of property boundary concentrations as a function of pollutant concentrations in the exhaust stream was analyzed. The maximum stack concentrations that resulted in the property boundary concentrations at the allowable limits were estimated using the air dispersion software. The exhaust flow rate was conservatively assumed to be 1,500 scfm, the maximum flow rate from the well field. Table C.6 lists the maximum exhaust concentrations.

Table C.6. Maximum Exhaust Pollutant Concentrations that Result in Property Boundary Concentrations at the Off-site Limit

Chemical	Off-site Limit	Maximum Exhaust Pollutant Concentration
	µg/m^3	ppmv
TCE	0.5	208
vinyl chloride	0.11	100
1,1-DCE	210	12,000
cis-1,2-DCE	37	21,000
trans-1,2-DCE	73	41,000

Based on this analysis, it is concluded that the operational limit of 20 ppmv is conservative. There is a substantial safety factor between the operational limit and the off-site limit. An exhaust concentration of 100 ppmv for vinyl chloride has the smallest safety factor of the pollutants analyzed.

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ATTACHMENT

AIR DISPERSION ANALYSIS REPORTS AND MODEL READY INPUT FILES

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CD—AERMOD INPUT AND OUTPUT FILES

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