Department of Energy

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AUG 2 9 2013

Mr. Todd Mullins
Federal Facility Agreement Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

PPPO-02-1969283-13B

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

Dear Mr. Mullins and Ms. Tufts:

TRANSMITTAL OF THE FIVE-YEAR REVIEW FOR REMEDIAL ACTIONS AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-1289&D1

Please find enclosed for your review the D1 *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D1. This Five-Year Review encompasses the remedial actions that the U.S. Department of Energy (DOE) has taken under the operable units identified at the Paducah Site, plus the Water Policy removal action, Surface Water Interim Corrective Measures, and Surface Water On-Site Sediment Removal. This Five-Year Review encompasses activities associated with response actions from January 2008 through December 2012. Section XXX of the Federal Facility Agreement for the Paducah Site includes requirements for synchronizing five-year reviews of remedial actions. The last five-year review at the Paducah Site was conducted in 2008 for the period January 2003 through December 2007.

This Five-Year Review has a trigger date for final approval of December 30, 2013. To meet the December 30, 2013, approval date, DOE requests comments on the subject document no later than October 28, 2013.

If you have any questions or require additional information, please contact Cynthia Zvonar at (859) 219-4066.

Sincerely,

Jennifer Woodard

Jennifer Woodard
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosure:
Five-Year Review

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DOE/LX/07-1289&D1
Secondary Document

Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-1289&D1
Secondary Document

Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—August 2013

Prepared for the
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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ACRONYMS

AM	Action Memorandum
AOC	area of concern
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirements
BGOU	Burial Grounds Operable Unit
CAB	Citizens Advisory Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
D&D	decontamination and decommissioning
DCS	derived concentration standard
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPT	Direct Push Technology
EE/CA	Engineering Evaluation/Cost Analysis
EI	environmental indicator
EIC	Environmental Information Center
ELCR	excess lifetime cancer risk
EM	environmental management
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EQ	equalization
ERH	Electrical Resistance Heating
EW	extraction well
FC	final characterization
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GPRA	Government Performance Results Act
GWOU	Groundwater Operable Unit
HI	hazard index
ICM	interim corrective measure
ICRP	International Commission on Radiological Protection
IRA	interim remedial action
ITR	Independent Technical Review
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	*Kentucky Revised Statutes*
LATA Kentucky	LATA Environmental Services of Kentucky
LUC	land use control
LUCAP	land use control assurance plan
LUCIP	land use control implementation plan
MCL	maximum contaminant level
MIP	membrane interface probe

MOA	Memorandum of Agreement
MW	monitoring well
NCP	National Contingency Plan
ND	nondetect
NEPCS	Northeast Plume Containment System
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NWPGS	Northwest Plume Groundwater System
O&M	operation and maintenance
OREIS	Oak Ridge Environmental Information System
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PHEA	Public Health and Ecological Assessment
PRG	Preliminary Remediation Goal
RA	remedial action
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RDR	Remedial Design Report
RDSI	Remedial Design Support Investigation
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCADA	supervisory control and data acquisition
SI	site investigation
SMP	Site Management Plan
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TBC	to be considered
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USCA	*United States Code Annotated*
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The cleanup strategy under the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) establishes five operable units (OUs): the Groundwater OU (GWOU), the Surface Water OU (SWOU), the Soils OU, Burial Grounds OU (BGOU), and the Decontamination and Decommissioning (D&D OU) (EPA 1998). Each OU is scoped to remediate areas and media associated with the Paducah Gaseous Diffusion Plant (PGDP). A final Comprehensive Site OU evaluation will occur following plant shutdown and completion of D&D of the gaseous diffusion plant (GDP), D&D of the Depleted Uranium Hexafluoride (DUF_6) Conversion Plant, and completion of post-shutdown cleanup of each of the post–GDP specific OUs. The specific scopes and further discussions for each OU are addressed in the Site Management Plan (DOE 2013a).

The U.S. Environmental Protection Agency (EPA) defines the following types of five-year reviews: (1) statutory review, (2) policy review, (3) discretionary review, and (4) five-year review addendum (for deferred protectiveness). This document is a combination of statutory, policy, and discretionary reviews because PGDP has implemented both removal and remedial actions.

This Five-Year Review encompasses the remedial actions that the U.S. Department of Energy (DOE) has taken under the respective OUs, plus the Water Policy removal action, Surface Water Interim Corrective Measures, and Surface Water On-site Sediment Removal. The FFA for PGDP includes requirements for synchronizing Five-Year Reviews of remedial actions (Section XXX). The triggering action for this review is the five-year anniversary of the third synchronized five-year review conducted at PGDP in 2008 for activities associated with response actions from 2003 through 2007. [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)]. This Five-Year Review encompasses activities associated with response actions from 2008 through 2012. A form summarizing PGDP, issues from the review, recommendations, and protectiveness statements is presented as Table ES.1. This form is the updated 2011 version of the form from Appendix F of EPA guidance document *Comprehensive Five-Year Review* (EPA 2001).

Table ES.1. Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Paducah Gaseous Diffusion Plant		
EPA ID: KY8-890-008-982		
Region: 4	State: KY	City/County: Paducah/McCracken
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? No	
REVIEW STATUS		
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy		
Author name (Federal or State Project Manager): Cynthia Zvonar		
Author affiliation: U.S. Department of Energy		
Review period: 01/01/2008–12/31/2012		
Date of site inspection: 01/17/2013–02/19/2013		
Type of review: Statutory, Policy, and Discretionary		
Review number: 4		
Triggering action date: 12/30/2008		
Due date (*five years after triggering action date*): 12/30/2013		

The table below is for the purpose of the summary form and associated data entry and does not replace the two tables required in Section VIII and IX by the FYR guidance. Instead, data entry in this section should match information in Section VII and IX of the FYR report.

<table>
<tr><th colspan="5">Issues/Recommendations</th></tr>
<tr><td colspan="5">OU(s) without Issues/Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td colspan="5">Burial Grounds</td></tr>
<tr><td colspan="5">Issues and Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td rowspan="3">OU(s): Groundwater, C-400 Electrical Resistance Heating (ERH)</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: The Record of Decision (ROD) selected ERH to address the volatile organic compound (VOC) source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting the remedial action objectives (RAOs) in the Upper Continental Recharge System and the upper Regional Gravel Aquifer (RGA); however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.</td></tr>
<tr><td colspan="4">Recommendation: Evaluate alternative technologies to achieve the RAO for the lower RGA (reduce the extent and mass of the VOC source). The FFA parties have agreed to conduct a treatability study to support remedy selection for the lower RGA. Upon completion of the treatability study, the FFA parties will determine the path forward for treatment of the lower RGA, and the decision documents for implementation will be modified as appropriate.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>TBD</td></tr>
</table>

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
OU(s): Groundwater, Northeast Plume	**Issue Category**: No Issue			
	Issue: N/A			
	Recommendation: The FFA parties recommended optimization of the Northeast Plume treatment system to increase trichloroethene and 1,1-dichloroethene mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The recommendation for optimization is planned for fiscal year 2013/2014. An evaluation of the results of the optimization of the Northeast Plume with field testing and use of the sitewide groundwater flow model is needed to understand the performance of the new extraction wells (EWs).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2017

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
OU(s): Groundwater, Water Policy	**Issue Category:** Remedy Performance			
	Issue: All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all landowners have signed license agreements on file for their properties; therefore, potential risk exists that residents would use their groundwater.			
	Recommendation: DOE will optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater. An annual educational fact sheet will be sent to each address within the Water Policy Box. Such a fact sheet would outline the potential risk associated with the groundwater and inform residents within the Water Policy Box of the groundwater remediation. Land ownership also will be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box. The newly identified owners will be contacted and given information concerning the contaminated groundwater. Raising the education and awareness levels about the potential risk associated with the groundwater will reduce the likelihood that residents would use their groundwater.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2014

OU(s): Surface Water, NSDD Sections 1 and 2	**Issue Category:** No Issue			
	Issue: N/A			
	Recommendation: Based on the residual risk evaluation concluding that the remaining contamination poses minimal risk based on the current and reasonably anticipated industrial exposure scenario, a request for modification of the North-South Diversion Ditch (NSDD) Land Use Control Implementation Plan will be submitted for the monitoring of the land use controls (LUCs) to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing annual verification of administrative controls and annual verification of access to once every five years for the NSDD Sections 1 and 2.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2014

OU(s): Surface Water, C-746-K Landfill	**Issue Category:** No Issue			
	Issue: N/A			
	Recommendation: The shaft of monitoring well (MW)301 has buckled so that any repair/replacement of the pump would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2014

OU(s): Surface Water, Interim Corrective Measures	**Issue Category:** No Issue			
	Issue: N/A			
	Recommendation: An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water Interim Corrective Measure (ICM) signs with Environmental Indicator (EI) signs, which serve to meet the objectives of the ICM signs. Specifically, the evaluation proposes that, where the signs are co-located, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. The fencing located at areas A7 and A8 will be removed, and signs located at A1 will be removed (see Figure ES.1).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2014

To add additional issues/recommendations here, copy and paste the above table as many times as necessary to document all issues/recommendations identified in the FYR report.

Protectiveness Statement(s)

Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Northwest Plume	Protective	N/A

Protectiveness Statement:

The remedy for the Northwest Plume is protective of human health and the environment.

The objective of this IRA is to initiate control of the source and mitigate the spread of contamination in the Northwest Plume. The optimization of the Northwest Plume IRA is intended to increase VOC mass removal and enhance the contaminant capture in the vicinity of the existing south wellfield located immediately north of the plant. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Northeast Plume	Protective	N/A

Protectiveness Statement:

The remedy for the Northeast Plume is protective of human health and the environment.

The objective of this IRA is to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the plant security fence. Optimization of the Northeast Plume is being pursued by the FFA parties. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Cylinder Drop Test Area	Protective	N/A

Protectiveness Statement:

The remedy for the Cylinder Drop Test Area is protective of human health and the environment.

The RAO for this remedy is intended to prevent rural residents from exposure to the only COC, TCE. This RAO has been met through treatment of soils to a concentration below cleanup goals, thereby reducing the amount of TCE available to leach to groundwater.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Water Policy	Protective	N/A

Protectiveness Statement:

The remedy for the Water Policy is protective of human health and the environment.

The objective of this removal action is to prohibit the use of contaminated groundwater and provide a safe, alternate water supply to the residents in the affected area. This objective has been met by providing affected residents access to municipal water in accordance with the Water Policy and corresponding license agreements, thereby reducing opportunities for exposure to contaminated groundwater.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, C-400 Electrical Resistance Heating	Will be Protective	N/A

Protectiveness Statement:

The interim remedial action for the VOC contamination at C-400 is expected to contribute to protectiveness of human health and the environment upon completion. In the interim, remedial activities completed to date have addressed adequately all exposure pathways that could result in unacceptable risks in these areas.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Southwest Plume	Will be Protective	N/A

Protectiveness Statement:

The remedial action for VOC sources at Southwest Plume is expected to contribute to protectiveness of human health and the environment upon completion. In the interim, remedial activities completed to date have addressed adequately all exposure pathways that could result in unacceptable risks in these areas.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, North-South Diversion Ditch Source Control	Protective	N/A

Protectiveness Statement:

The remedy for the NSDD Source Control is protective of human health and the environment.

The objective of this IRA is to initiate control of the source of continued contaminant releases into the NSDD and mitigate the spread of contamination from the NSDD. This objective was achieved by mitigating the discharge of contaminants into NSDD, institutional controls to limit the potential for direct exposure, and engineering controls to mitigate the infiltration and migration of contaminants from the NSDD to the subsurface environment and off-site (i.e., outside the existing security fence).

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, North-South Diversion Ditch Sections 1 and 2	Protective	N/A

Protectiveness Statement:

The removal action for the NSDD Sections 1 and 2 is protective of human health and the environment.

The ROD established the following RAOs: prevention of future discharge of process water to the NSDD; reduction of the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water; and prevention of future on-site runoff from being transported off-site (i.e., outside the existing security fence) via the NSDD. The RAOs have been achieved effectively through excavation of contaminated sediment and placement of clean soil to meet the cleanup goal and implementation of LUCs assuring protectiveness.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, C-746-K Landfill	Protective	N/A

Protectiveness Statement:

The remedy for the C-746-K Landfill is protective of human health and the environment.

The RAOs for this unit are to control the release of COCs from the unit, limit direct contact by humans, and reduce overall risks to ecological receptors. The RAOs have been met through the reduction of human risks by posting warning signs and other institutional controls and through the reduction of ecological risks by installing riprap over exposed acidic leachate seeps.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, Fire Training Area	Protective	N/A

Protectiveness Statement:

The remedy for the Fire Training Area is protective of human health and the environment.

The selected remedy for the Fire Training Area, which rested upon the surrounding area remaining industrialized, is no further action (outside of maintaining institutional controls). The same land use that was in place and relied upon to support no further action still is in place and remains effective. This also is consistent with the expected future use of the area, as described in the SMP.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water Interim Corrective Measures	Protective	N/A

Protectiveness Statement:

The remedy for the surface water ICMs is protective of human health and the environment.

The objective of the surface water ICMs work plan is to design a system of institutional controls that will identify the areas of contamination through posting of warning signs and restrict casual public access to the creeks. This objective has been met through posting of warning signs and constructing fences near bridges crossing affected streams. These institutional controls serve to inform the public about the areas of contamination, resulting in a reduction of casual public access to the streams.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, On-site Sediment Removal	Protective	N/A

Protectiveness Statement:

The remedy for the Surface Water On-site Sediment Removal is protective of human health and the environment.

The RAOs for this unit were to ensure that direct contact risk at the on-site ditches for the current industrial worker falls within the EPA risk range and to ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range. These RAOs were met by excavating contaminated sediment/soil and placing clean soil to meet the cleanup goal.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Burial Grounds OU, C-749 Uranium Burial Ground	Protective	N/A

Protectiveness Statement:

The remedy for the C-749 Uranium Burial Ground is protective of human health and the environment.

The RAOs for the interim action were to mitigate migration of uranium and TCE from the C-749 Uranium Burial Ground to groundwater and to prevent disturbance or contact with the buried waste materials. The interim ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls. The interim action, as implemented, provides protection by mitigating direct contact with the buried waste through DOE ownership and use of the property. Alternatives for final action at SWMU 2 currently are being evaluated under the SWMUs 2, 3, 7, and 30 BGOU FS.

Sitewide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Protective	N/A

Protectiveness Statement:

Overall, the selected remedies implemented thus far are protective, but PGDP cleanup activities are still ongoing with additional future actions planned. The groundwater exposure pathways for PGDP are being controlled by providing affected residents access to municipal water under the Water Policy, combined with a series of source and plume control actions to reduce off-site contaminant migration. Other exposure pathways for other media (e.g., soil and sediment) are being controlled through individual OU actions along with DOE ownership and use of the property.

*Off-site is defined as off DOE property for this document unless otherwise noted.

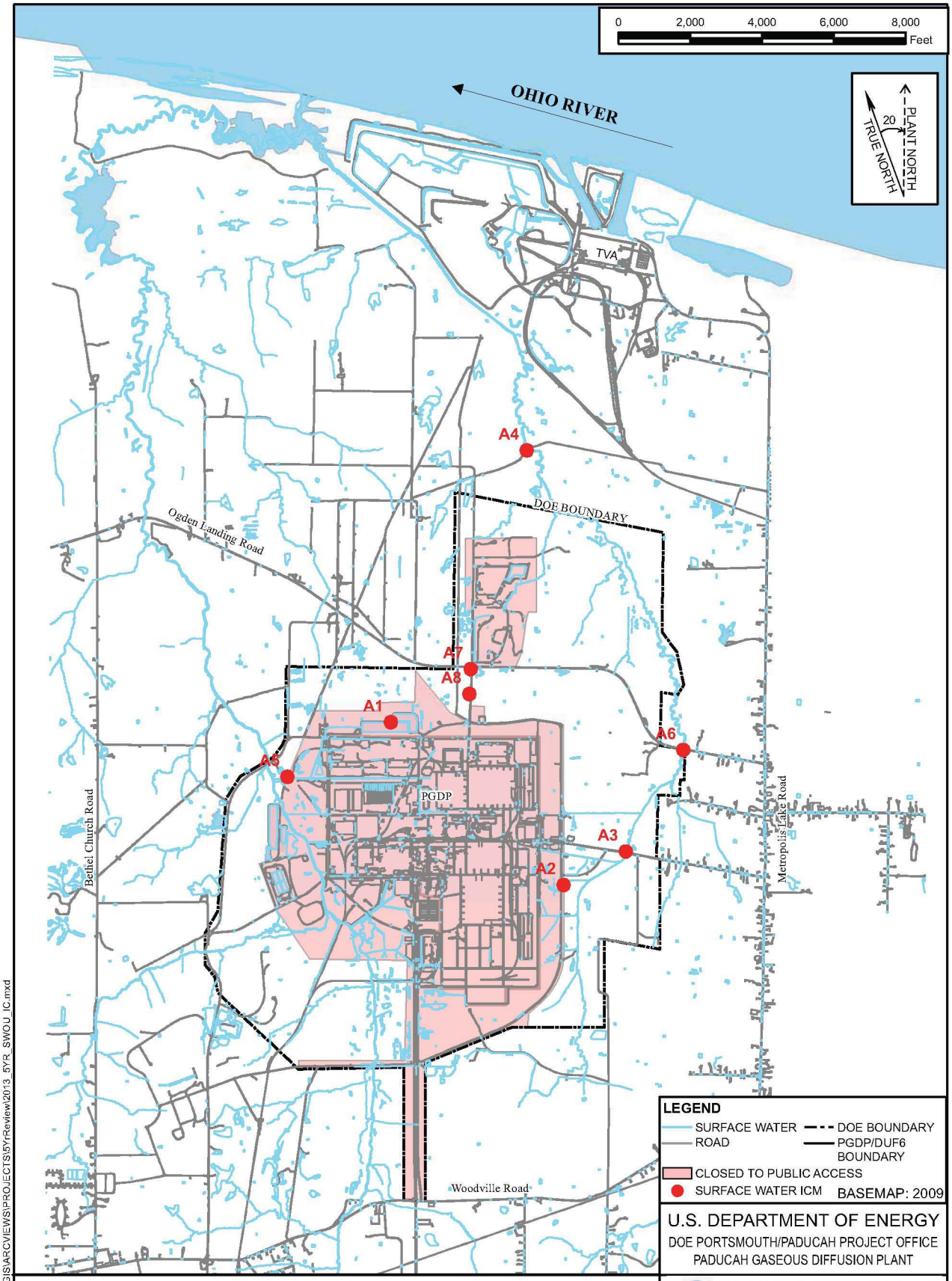

Figure ES.1. Location of Signs and Fencing Installed for the Surface Water ICM

The assessments of this Five-Year Review find that DOE has implemented and operated the remedies in accordance with the requirements of the RODs or Action Memorandums (AMs). Table ES.2 is a list of the continuing or completed response actions by decision document, site or project name and OU contained in this Five-Year Review.

Table ES.2. Decision Document and Site/Project Name Included in 2013 Five-Year Review

Decision Document	Site or Project	Operable Unit
Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1143&D4, and *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2	Northwest Plume	GWOU
Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume	GWOU
Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1527&D2	Cylinder Drop Test Area or Lasagna™	GWOU
Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1201&D2	Water Policy	GWOU
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	C-400 Electrical Resistance Heating	GWOU
Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0365&D2/R1	Southwest Plume	GWOU
Record of Decision for Interim Action Source Control at the North-South Diversion Ditch, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1213&D3	North-South Diversion Ditch Source Control	SWOU
Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-1948&D2	North-South Diversion Ditch Sections 1 and 2	SWOU
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	C-746-K Landfill	SWOU
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	Fire Training Area	SWOU
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water Interim Corrective Measures	SWOU
Action Memorandum for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0119&D2/R1	Surface Water On-site Sediment Removal	SWOU
Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1351&D1	C-749 Uranium Burial Ground	BGOU

The response actions are functioning as intended by the decision documents. Each of these projects had specific remedies cited in each applicable decision document (i.e., ROD or AM). This Five-Year Review concludes, for completed response actions, that additional actions are not required to meet the remedial or RAOs of the decision documents.

1. INTRODUCTION

The purpose of this Five-Year Review is to determine whether the remedies at the Paducah Gaseous Diffusion Plant (PGDP) remain protective of human health and the environment and evaluate the implementation and performance of the selected remedies. The methods, findings, conclusions, and recommendations of reviews of 13 projects are documented in this report. This Five-Year Review is part of the Administrative Record (AR) at PGDP.

The U.S. Department of Energy (DOE) has conducted this Five-Year Review pursuant to the Federal Facility Agreement (FFA) (EPA 1998) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [42 *USCA* § 9621(c)]; the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *CFR* § 300.400(f)(4)(ii)]; and the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P (EPA 540-R-01-007) (EPA 2001). Additionally, this document meets guidance set forth in the "Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Review Guide," Office of Environmental Management, DOE, March 2002 (unnumbered); Assessing Protectiveness at Sites for Vapor Intrusion Supplement to the "Comprehensive Five-Year Review Guidance," OSWER 9200.2-84; Recommended Evaluation of Institutional Controls: Supplement to the Comprehensive Five-Year Review Guidance Five-Year Reviews, OSWER 9355.7-18; Frequently Asked Questions (FAQs) and Answers, Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews, OSWER 9355.7-21; Memorandum issued September 13, 2012, OSWER 9200.2.111. Per guidance, community involvement activities during the five-year review should include notifying the community that the five-year review will be conducted. DOE published a public notice in the local newspaper on March 17, 2013, announcing the Five-Year Review has been initiated and requesting that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. No comments were received.

CERCLA requires that reviews be conducted no less often than once every five years. The FFA, Section XXX, requires a five-year review for final remedial actions for any operable unit (OU). EPA Guidance (OSWER 9355.7-21) defines the following types of Five-Year Reviews: (1) Statutory Reviews; (2) Policy Reviews; (3) Discretionary Reviews; and (4) Five-Year Review Addendum (for deferred protectiveness).

Statutory Reviews are conducted pursuant to CERCLA §121(c) and 40 *CFR* §300.430(f)(4)(ii) of the NCP and are conducted when the following conditions exist:

- Upon completion of the remedial action [RA], hazardous substances, pollutants, or contaminants will remain on site above levels that allow for unlimited use and unrestricted exposure; and

- The ROD [Record of Decision] for the site was signed on or after October 17, 1986, (the effective date of [Superfund Amendments and Reauthorization Act] SARA) and the remedial action was selected under CERCLA §121.

Policy Reviews are generally conducted for the following types of actions:

- A pre- or post-SARA remedial action that, upon completion, will not leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete;

- A pre-SARA remedial action that leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure; or

- A removal-only site on the NPL [National Priorities List] where a removal action leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure and where no remedial action has or will take place.

Discretionary reviews are not required by statute or policy. These types of Five-year Reviews may be done at the discretion of the region or federal agency to help ensure the protectiveness of selected remedies. A five-year review addendum generally is completed for remedies where the protectiveness determination was deferred in a prior five-year review report in order to collect further information.

All the projects listed in Table 1.1 are undergoing a Statutory Five-Year Review with the exception of the Northwest Plume, Northeast Plume, C-400 ERH, Water Policy, Surface Water Interim Corrective Measures (ICMs), and Surface Water On-site Sediment Removal. The Northwest Plume project, C-400 ERH, and Northeast Plume Project are being conducted as Policy Reviews because these actions are interim remedial actions (IRAs) whereby the objectives are not intended to obtain health-based levels to achieve unlimited use and unrestricted exposure and/or may operate for five years or longer. Five-Year Reviews are being conducted for the Water Policy, Surface Water ICM, and Surface Water On-site Sediment Removal as Discretionary Reviews. No Five-Year Addendum reviews are being conducted.

The Water Policy is a removal action that originally was implemented and currently is being maintained to eliminate and/or reduce potential exposure from contaminated groundwater at PGDP. Various remedial action projects at PGDP rely on the Water Policy to demonstrate protectiveness for the groundwater exposure pathway. The Surface Water ICM was conducted as a Resource Conservation and Recovery Act (RCRA) ICM intended to identify the areas of contamination through the posting of warning signs and will restrict casual public access to the creeks. Proper monitoring and maintenance of these controls are necessary to demonstrate ongoing protectiveness for the surface water exposure pathway until such time that a final remedial action is implemented as part of the Surface Water Operable Unit (SWOU). The Surface Water On-site Sediment Removal was conducted as a removal action to remove on-site areas of elevated sediment contamination. The removal action reduced contaminant levels to within the acceptable CERCLA risk range based on the current and reasonably anticipated future land use (industrial, recreational), but did not achieve cleanup levels that would allow for unlimited use and unrestricted exposure.

This review encompasses the response actions listed in Table 1.1 by decision document, site/project name, and OU.

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review

Decision Document	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1143&D4 and *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2	Northwest Plume	Ground-water Operable Unit (GWOU)	Northwest Plume

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

Decision Document	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume	GWOU	Northeast Plume
Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1527&D2	Cylinder Drop Test Area or LasagnaTM	GWOU	Solid Waste Management Unit (SWMU) 91
Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1201&D2	Water Policy	GWOU	Water Policy
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	C-400 Electrical Resistance Heating (ERH)	GWOU	GWOU C-400 ERH, currently underway
Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0365&D2/R1	Southwest Plume	GWOU	New to Five-Year Review, currently underway
Record of Decision for Interim Action Source Control at the North-South Diversion Ditch, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1213&D3	North-South Ditch (NSDD) Source Control	SWOU	NSDD Source Control
Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky, DOE/OR/07-1948&D2	NSDD Sections 1 and 2	SWOU	New to Five-Year Review
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	C-746-K Landfill	SWOU	Waste Area Groups (WAGs) 1 and 7, SWMU 8
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	Fire Training Area	SWOU	WAGs 1 and 7, SWMU 100
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
Action Memorandum for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0119&D2/R1	Surface Water On-Site* Sediment Removal	SWOU	New to Five-Year Review

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

Decision Document	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1351&D1	C-749 Uranium Burial Ground	Burial Grounds Operable Unit (BGOU)	WAG 22, SWMU 2

*On-site is defined in this document as on DOE property.

The FFA includes provisions for combining Five-Year Reviews of remedial actions as stated in Section XXX:

> Consistent with Section 121(c) of CERCLA, 42 USC § 9621 (c), and in accordance with this Agreement, DOE agrees that if the selected, final RAs for any operable unit, including selected alternatives entailing institutional controls with remedial action, result in Hazardous Substances, pollutants or contaminants, or Hazardous Wastes and Hazardous Constituents remaining at the Site above levels that allow for unlimited use and unrestricted exposure in accordance with Section 300.430(f) (4) (ii) of the NCP, DOE will submit to EPA and KNREPC* a review of the RAs no less often than once every five (5) years (Five Year Review) after the initiation of such RAs (i.e., date of issuance of final-ROD) for as long as the site remains on the NPL to assure that human health and the environment are being protected by the RAs being implemented. To facilitate the Five Year Review process for multiple OUs, the Five Year Reviews shall be synchronized as follows: reviews which are required for RA OUs will be conducted every five years starting from the initiation of the RA for the first OU. Every five years thereafter, all subject OU RAs which were started prior to the next Five Year Review date, shall be included in the next Five Year Review. For OU RAs which started after the most recent Five Year Review, the level of the review shall be commensurate to the completeness of the RA and the quantity of operation and maintenance data collected.
>
> If, based on the Five-Year Review, it is the judgment of EPA or KNREPC that additional action or modification of a RA is appropriate in accordance with Sections 104, 106 or 120 of CERCLA, 42 USC § 9604, 9606, or 9620, the RCRA Permits or KRS 224 Subchapter 46, then EPA or KNREPC shall require DOE to submit a proposal to implement such additional or modified actions, which shall be subject to review and approval by EPA and KNREPC.
>
> *KNREPC now is called the Kentucky Energy and Environment Cabinet.

DOE is the lead agency for these response actions, and EPA and the Kentucky Department for Environmental Protection (KDEP) provide regulatory oversight pursuant to the FFA. This Five-Year Review contains reviews of completed projects and summaries of projects currently underway. The triggering action for this review is the five-year anniversary of the third combined Five-Year Review conducted at PGDP [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)].

This Five-Year Review is used to accomplish the following [DOE 2002a (unnumbered)]:

1. Evaluate whether the remedy is operational and functional;

2. Evaluate those assumptions critical to the effectiveness of remedial measures or the protection of human health and the environment (e.g., land use, site conditions, applicable standards) made at the time of the remedial decision to determine, given current information, whether these assumptions are still valid;

3. Determine what corrective measures are required to address any identified deficiencies; and

4. Evaluate whether there are opportunities to optimize the long-term performance of the remedy or reduce life-cycle costs.

EPA Region 4 issued a policy in April 1998 for assuring the long-term effectiveness of land use controls (LUCs) at federal facilities (Johnston 1998). PGDP subsequently developed a site-specific Memorandum of Agreement (MOA) and Land Use Control Assurance Plan (LUCAP) (DOE 2000b). The PGDP LUCAP specifies that decision documents approved prior to the effective date of the MOA in which LUCs were selected as part of the remedy will be analyzed for the effectiveness of the LUCs during the ROD Five-Year Reviews. The effectiveness of the institutional controls or LUCs is addressed in this Five-Year Review.

The review of the completed response actions was conducted during January through April 2013 for the period extending from January 2008 through December 2012. DOE and its prime remediation contractor, LATA Environmental Services, LLC, (LATA Kentucky) conducted the reviews. Chapter 4 of this report identifies the locations of the actions that were reviewed. Components of this review are as follows:

- Document review
- Data review
- Site inspection
- Interviews of personnel responsible for specific aspects of some of the response actions
- Five-Year Review Report development and review

These components are described in more detail in Chapter 22.

Protectiveness statements are developed after the technical review is completed and the following questions are answered:

- Question A: Is the Remedy Functioning as Intended by the Decision Documents?

- Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Selection Still Valid?

- Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

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2. SITE CHRONOLOGY

In August 1988, trichloroethene (TCE), an organic solvent, and technetium-99 (Tc-99), a beta-emitting radionuclide, were detected in four private wells north of the PGDP facility. DOE placed affected residences/businesses on alternate water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. Since that time, several investigations and response actions have taken place. Table 2.1 contains key dates that are important to the environmental response program of PGDP.

Table 2.1. Chronology of Significant Site Events at PGDP

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
1952	PGDP begins enriching uranium for nuclear fuel reactors.	N/A	N/A	N/A	N/A	N/A	N/A
1964–1965, 1979	PGDP conducts cylinder drop tests using TCE pit [later to be designated Solid Waste Management Unit (SWMU) 91].	N/A	GWOU	N/A	91	Ground-water	N/A
Aug–1988	Off-site* groundwater contaminants are discovered in neighboring residential wells. DOE immediately provided a temporary water supply. Initiated construction activities to supply municipal water.	N/A	GWOU	N/A	N/A	Ground-water	N/A
Nov–1988	Agreed Consent Order is signed.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1991	Kentucky Hazardous Waste Management Permit and EPA Hazardous and Solid Waste Amendments Permits are first effective.	N/A	N/A	N/A	N/A	N/A	N/A
May–1993	PGDP applies for listing on National Priorities List (NPL).	N/A	N/A	N/A	N/A	N/A	N/A
Jul–1993	Implemented institutional controls (fencing/posting) for off-site contamination in surface water, outfalls, and lagoons.	Exterior drainage ditches	SWOU	18 and 25	58–69, 168, 171, 199	Surface water	ICM
Jul–1993	Issued ROD for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northwest Plume.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Mar–1994	Issued ROD that instituted action to treat certain plant effluent and control the migration of contaminated sediment associated with the North-South Diversion Ditch (NSDD).	North-South Diversion Ditch	SWOU	25	59	Surface water	IRA
May–1994	PGDP is placed on NPL.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1994	Action memorandum approved for extended municipal water line to residents affected by off-site groundwater contamination.	Water Policy	GWOU	26	201, 202	Ground-water	Non-time-critical Removal action

Table 2.1. Chronology of Significant Site Events at PGDP (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Jun–1995	Issued ROD for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northeast Plume.	Northeast Plume	GWOU	26	202	Ground-water	IRA
Aug–1995	Northwest Plume Groundwater System begins operation.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Sept–1995	The interim ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls. Through agreement of the parties, an impermeable cap was not constructed [Waste Area Grouping (WAG) 22 Post-ROD Change, October 23, 1996]. This change also will be documented in the Final Remedial Decision for SWMU 2.	C-749 Uranium Burial Ground	BGOU	22	2	Soil and Ground-water	IRA
Feb–1997	Northeast Plume Groundwater System begins operation.	Northeast Plumes	GWOU	26	202	Ground-water	IRA
Feb–1998	FFA is signed with the EPA and KDEP.	N/A	N/A	N/A	N/A	N/A	N/A
Jul–1998	First Five-Year Review is completed for Northwest Plume Action.	Northwest Plume	GWOU	26	201	N/A	IRA
Aug–1998	First Five-Year Review is completed for Water Policy.	Water Policy	GWOU	26	201, 202	N/A	N/A
Aug–1998	Issued ROD for *in situ* treatment of TCE-contaminated soils using the LASAGNA™ technology.	Cylinder Drop Test Area	GWOU	27	91	Soil	IRA
Aug–1998	Issued ROD for installation of rip-rap along creek bank to prevent direct contact, implementation of institutional controls, and long-term monitoring and enhancement of existing cap to reduce leachate migration from surface infiltration.	C-746-K Landfill	SWOU	1 & 7	8	Surface water and sediment	IRA
Aug–2000	First Five-Year Review is completed for BGOU.	Burial Ground	BGOU	22	2, 3	Soil and ground-water	N/A
Aug–2000	First Five-Year Review is completed for SWOU.	Surface Water	SWOU	**	**	Surface water	N/A
Dec–2001	Lasagna™ or Cylinder Drop Test Area remedial operations are completed.	Cylinder Drop Test Area	GWOU	27	91	Soil	IRA
Aug–2002	Initiated removal of process equipment and piping for C-410 Decontamination and Decommissioning (D&D).	C-410 Infrastructure Removal	D&D	30	478	Building structures	Non-time-critical removal action

Table 2.1. Chronology of Significant Site Events at PGDP (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Sep–2002	Remedial action for Sections 1 and 2 of the NSDD	North-South Diversion Ditch	SWOU	25	59	Sediment and soil	IRA
Dec–2003	First combined Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Aug–2005	Issued ROD for *in situ* treatment of TCE source areas in the Upper Continental Recharge System (UCRS) and Regional Gravel Aquifer (RGA) located in the southeast and southwest corners of the C-400 building using ERH technology.	C-400 ERH	GWOU	6	11 & 533	Ground-water	IRA
Dec–2005	Initiate removal, characterization, and disposal of building structure and contents.	C-402 Lime House, C-405 Incinerator	D&D	30	480 & 55	Building structures	Non-time-critical removal action
Nov–2008	Second combined Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Apr–2009	Action Memorandum (AM) approved for the removal of contaminants associated with sediment in Sections 3, 4, and 5 of the NSDD and Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls 001, 008, 010, 011, and 015, and associated internal ditches and areas of PGDP.	Surface Water On-site Sediment Removal	SWOU	N/A	58; 69; 63; 66; 67; 68 and associated internal ditches and areas (including SWMUs 92 and 97)	Sediment and soil	Non-time-critical removal action
May–2009	AM approved for the removal of lead-contaminated soil at the C-218 Firing Range (SWMU 181). Removal of contamination within the respective SWMU boundaries of C-410-B (SWMU 19). Removal of contamination within the respective SWMU boundaries of C-403 (SWMU 40).	Soils Inactive Facilities Removal	Soils	N/A	19, 40 & 181	Soil	Non-time-critical removal action

Table 2.1. Chronology of Significant Site Events at PGDP (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Nov–2009	Issued addendum to document a change in scope of the C-410 removal action to 1) expand the scope of the existing non-time-critical removal action to include facility structure demolition to the slabs and disposition of demolition debris and 2) allow the nonprocess systems to remain in place and to remove these systems at the same time the building is demolished using heavy equipment such as an excavator with shears.	C-410 Infrastructure Removal	D&D	30	478	Building structures	Non-time-critical removal action
May–2010	Issued the AM for the decommissioning of the C-340 Metals Plant and C-746-A East End Smelter, which entailed the demolition of C-340-A, -B, and –C structures as well as the C-746-A East End Smelter. The slabs and soils underlying these structures will be addressed in future CERCLA response actions.	C-340 Decommis-sioning and C-746-A, East End Smelter	D&D	N/A	477 and 137	Building structures	Non-time-critical removal action
Sept–2010	Issued an Explanation of Significant Differences to the ROD for the IRA of Northwest Plume. The Northwest Plume Groundwater Treatment System was optimized by placing existing southern extraction wells (EWs) on standby and installing two new EWs east of original southern extraction field.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Mar–2012	Issued ROD for: SWMU 1—*In situ* source treatment using deep soil mixing with interim land use controls (LUCs). SWMU 211-A—*In situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon [Remedial Design Support Investigation (RDSI)] results. SWMU 211-B—*In situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon RDSI results.	Southwest Plume	GWOU	N/A	1 & 211A & B	Soil	Remedial Action

*Off-site is defined as off DOE Property unless otherwise noted.
**The 2000 Five-Year Review for SWOU addresses the surface water associated with 39 SWMUs.

3. BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

PGDP is located in northwestern Kentucky, approximately 10 miles west of the city of Paducah, and approximately 3.5 miles south of the Ohio River (Figure 3.1). The total acreage of land held by DOE at the Paducah Site is 3,556 acres. The industrial portion of PGDP is approximately 650 acres located within a fenced security area. Surrounding the industrial portion of the reservation is the West Kentucky Wildlife Management Area (WKWMA).

3.2 LAND AND RESOURCE USE

During the January 2008 through December 2012 review period, PGDP remained an active uranium enrichment plant. The plant is owned by DOE and was leased to and operated by the United States Enrichment Corporation (USEC) during the review period. Enrichment operations began in 1952, and the plant became fully operational in 1955. Hazardous, nonhazardous, and radioactive wastes have been generated, stored, and disposed of at PGDP. The industrial portion of PGDP, designated as secured (i.e., fenced and patrolled) industrial land use, includes numerous buildings and offices, support facilities, equipment storage areas, and active and inactive waste management units. The Depleted Uranium Hexafluoride (DUF_6) Conversion Project located at PGDP converts DUF_6 stored at Paducah into a more stable chemical form suitable for beneficial reuse or disposal.

DOE currently holds a lease agreement with USEC for the production facilities at PGDP and a license with the Commonwealth of Kentucky for certain portions of the WKWMA. Portions of both the DOE Reservation and WKWMA occupy land that once was part of the Kentucky Ordnance Works, a trinitrotoluene production facility in operation between 1942 and 1946. The entire WKWMA covers approximately 6,823 acres. The land licensed to the WKWMA is designated as recreational and is used extensively for outdoor recreation such as hunting and fishing. DOE property not leased to the WKWMA and outside the security area is classified as on-site, unsecured (i.e., not fenced) industrial. Figure 3.2 is a map showing the land use areas surrounding PGDP.

North of the DOE Reservation and WKWMA is the Shawnee Fossil Plant, operated by the Tennessee Valley Authority (TVA). This TVA property is designated as industrial.

Private property surrounds the DOE Reservation, WKWMA, and TVA. This property is mostly rural and agricultural. Residents and businesses in the surrounding area are served by a municipal water supply and private wells (if not subject to restriction under DOE's Water Policy). The municipal water supply is serviced by the West McCracken Water District. The district's water source is the Ohio River upstream of DOE Reservation.

As noted above, PGDP is located approximately 10 miles west of Paducah, Kentucky, in the western part of McCracken County [population approximately 65,000 (DOC 2011)]. The total population within a 50-mile radius of PGDP is approximately 534,000. Based on population data from the 2010 census, approximately 104,000 people live within 20 miles of PGDP and homes are scattered along rural roads around the plant. The population of Paducah, based on the 2010 U.S. Census, is 26,307. The closest communities to PGDP are the unincorporated towns of Grahamville and Heath which are 1.24 and 1.86 miles east of the plant, respectively. The nearest schools are Heath Elementary, Middle, and High Schools. These are 1.86 miles southeast of the plant near the Heath community. The nearest hospitals are located in Paducah. PGDP is near the following major roads: U.S. Highway 60 and Kentucky

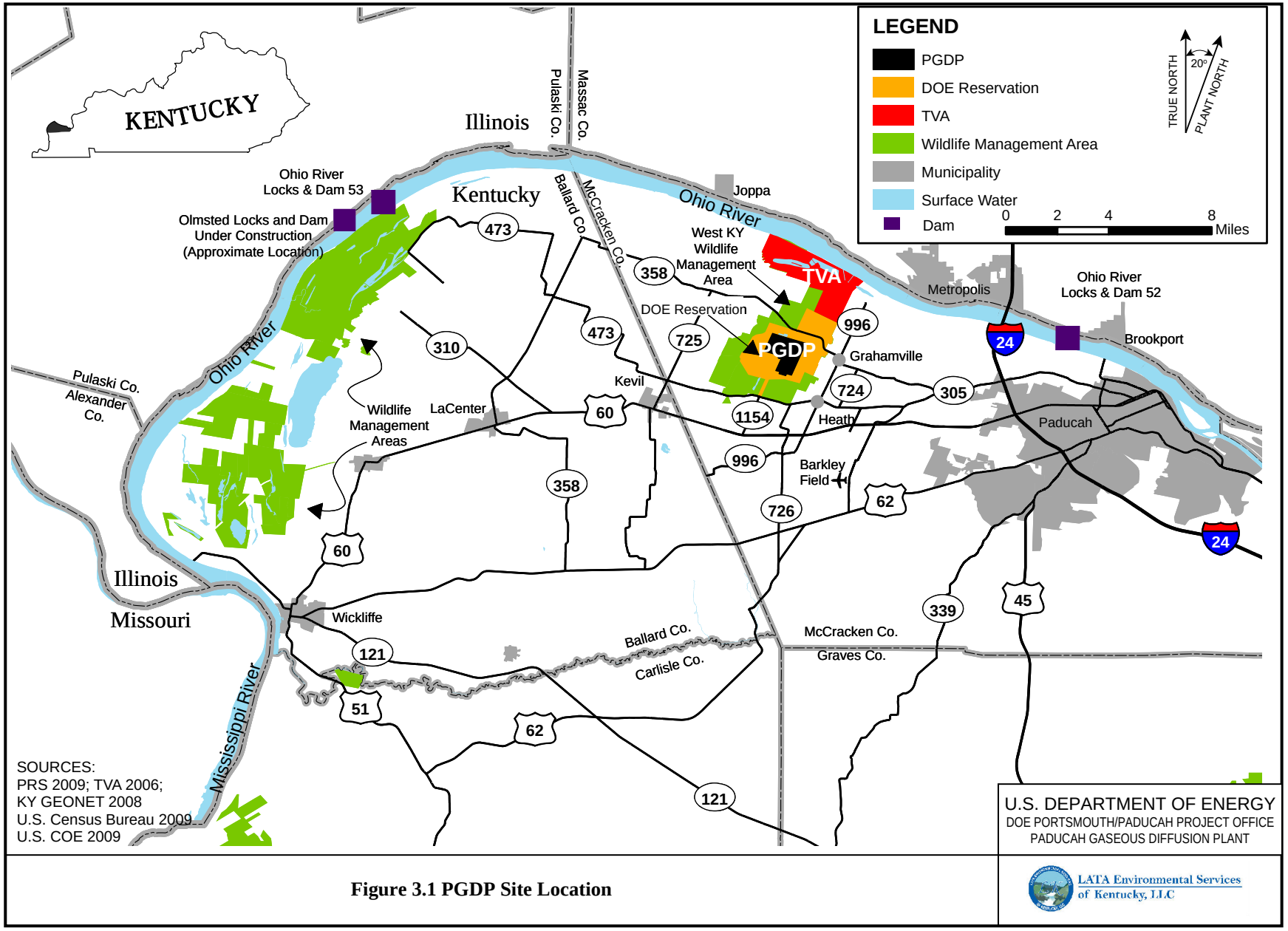


Figure 3.1 PGDP Site Location

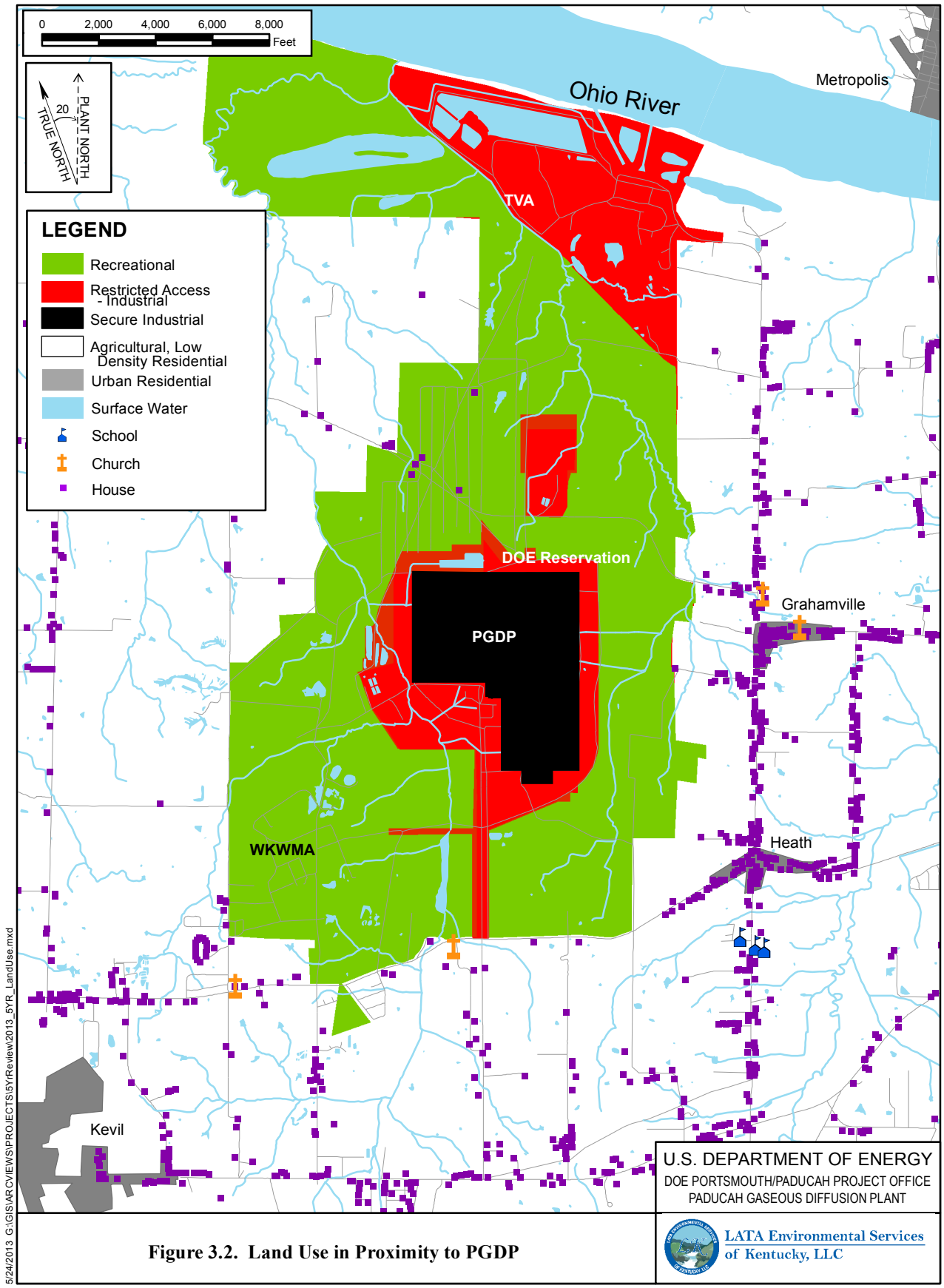


Figure 3.2. Land Use in Proximity to PGDP

Highways 358, 725, and 996. Additional major roads at greater distance are Interstate 24 and U.S. Highway 62. A rail spur serves PGDP and connects to the Illinois Central Gulf Railroad. The nearest airport is Barkley Regional Airport located approximately 3.7 miles southeast of the PGDP. Metropolis, Illinois, and Kevil, Kentucky, are the nearest municipal areas and are shown as urban residential land use (see Figure 3.2).

The Ohio River is navigable along its entire length and, near PGDP, has a downstream connection to the Mississippi River and an upstream connection to the Tennessee River. Dams (i.e., Locks and Dams 52 and 53) are located on the Ohio River, both upstream and downstream of PGDP. The Olmstead Locks and Dam currently are under construction to replace Locks and Dam 52 and 53, with an estimated operational date of 2020. In addition, the Kentucky Lock and Dam is located on the Tennessee River near its confluence with the Ohio River. Figure 3.1 is a map showing the land use areas surrounding PGDP.

Several groundwater-bearing zones are present in the PGDP area. The primary water-bearing units, in order of increasing depth, are the UCRS, the RGA, and the McNairy Formation (Figure 3.3). The RGA has been identified as the uppermost aquifer at PGDP (MMES 1992). The RGA is the dominant groundwater flow system at PGDP and contains the on-site and off-site contaminant plumes.

Groundwater flow is predominately vertically downward in the UCRS, providing recharge to the RGA. Rainfall infiltration and leakage from PGDP water utilities account for most of the recharging water. In general, the depth to the UCRS water table is less than 20 ft in the western half of PGDP (as shallow as 5 ft in some areas) and as much as 40 ft in the northeastern corner.

The RGA typically has a relatively high hydraulic conductivity and serves as the dominant flow system in the area. Hydraulic gradients direct groundwater flow in the RGA laterally to the north where the regional groundwater systems discharge into the Ohio River. Additionally, discharges of contaminated groundwater to surface water occur at seeps in Little Bayou Creek. The groundwater in these seeps contains contaminants associated with the Northwest Plume.

Silts and fine sands of the McNairy Formation, found beneath the RGA sediments, form the lower confining unit to the shallow aquifer system. The regional groundwater flow direction in the McNairy Formation is toward the Ohio River. Vertical hydraulic gradients in the McNairy Formation are downward beneath PGDP, but upward near the Ohio River.

PGDP is located in the western portion of the Ohio River basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, PGDP is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek), and Little Bayou Creek.

The plant is situated on the divide between Little Bayou and Bayou Creeks (Figure 3.4). Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP and extends northward to the Ohio River. Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and 100% of flow within Little Bayou Creek.

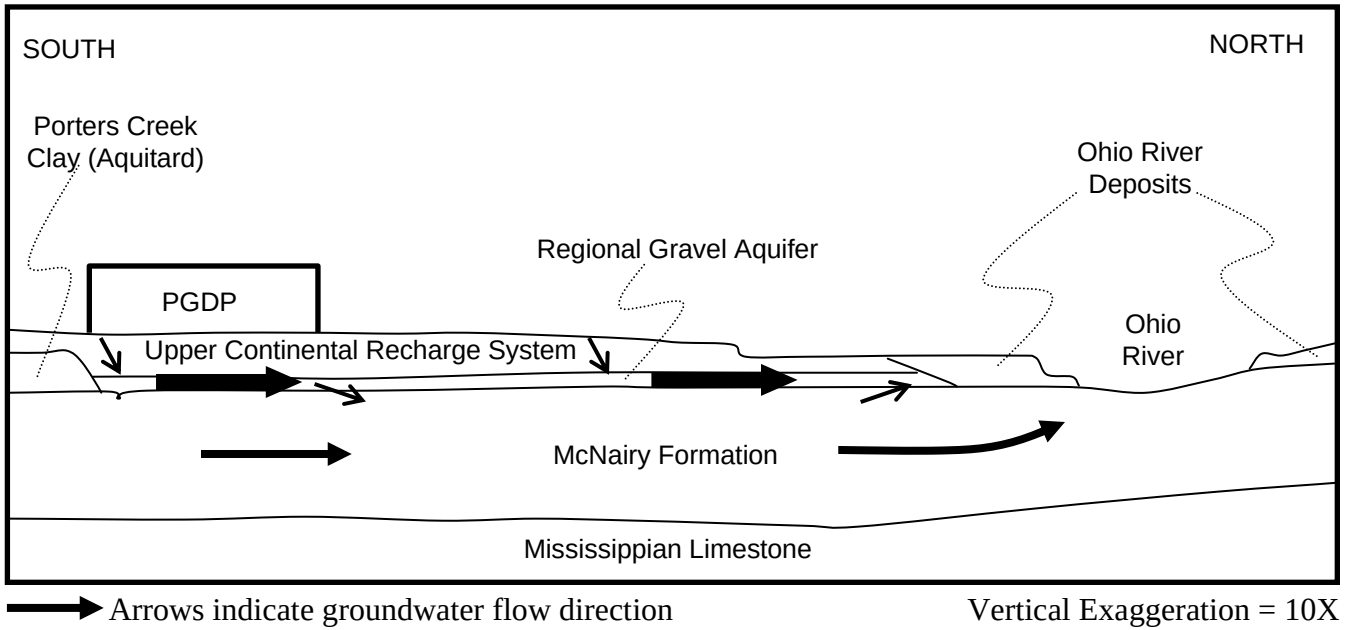
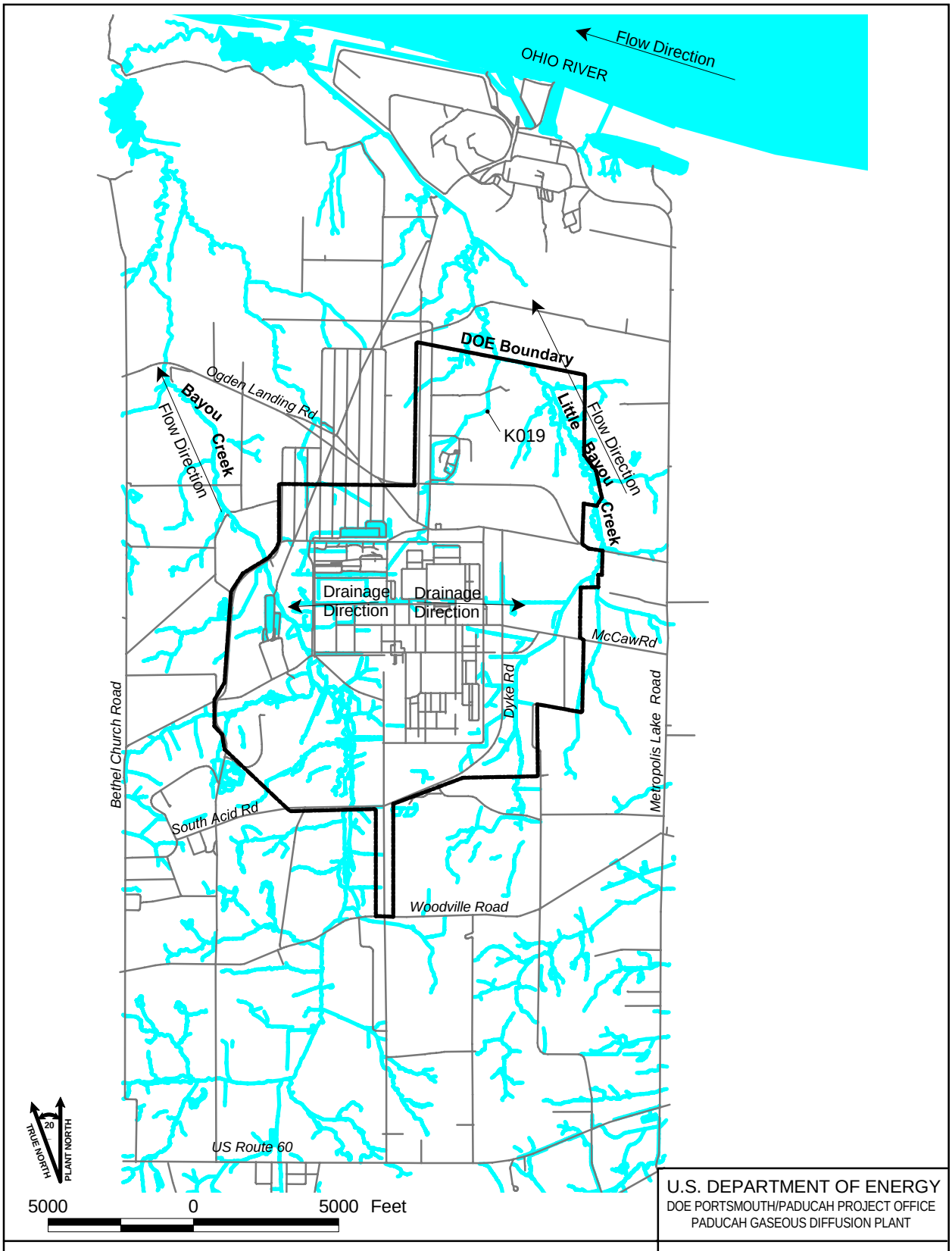


Figure 3.3. Water-Bearing Zones in the PGDP Area



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DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 3.4. Surface Water Features in the Vicinity of the DOE Site

LATA Environmental Services of Kentucky, LLC

Figure No. Fig 3-4 Revised 4-13.pdf
DATE 4-9-2013

3.3 HISTORY OF CONTAMINATION

Historical activities at PGDP have generated various nonhazardous, hazardous, and radioactive wastes that have been managed, stored, and/or disposed of by different methods. These activities have, in some cases, resulted in the release of contaminants to the environment. The primary contaminants of concern (COCs) at PGDP are Tc-99, TCE, polychlorinated biphenyls (PCBs), and uranium. In August 1988, contamination was found in an off-site drinking water well north of PGDP. The contaminants included Tc-99, which is a man-made radionuclide created as a byproduct of the fission of uranium. Initially, Tc-99 was introduced to PGDP in 1953 as a contaminant in feed material during a program in which spent nuclear reactor fuel was fed into the plant processes.

Further sampling showed that a commonly used solvent, TCE, also was present in off-site wells. TCE had been used as a cleaning solvent at PGDP since its construction, but has not been used since 1993 (DOE 2001a). In the C-400 Building, process piping and equipment from the cascade system were cleaned with TCE. In 1986, TCE was found to have been discharged inadvertently (apparently for many years) from a sump pump in the degreaser area of C-400 to a storm sewer and was found to have leaked into the soil. Other potential sources of TCE releases at PGDP are the TCE degreaser at the C-720 Building and switchyard transformers that were washed with TCE. Reportedly, TCE also was used in the Kellogg Building during plant construction. Waste TCE was disposed of in on-site landfills and in a historical landfarming operation. In PGDP cylinder drop test, TCE was placed into a pit and used as a refrigerant in tests to determine cylinder integrity (Chapter 7).

PCBs have been found in sediment and fish downstream of the plant. PCBs have been used extensively as an insulating, nonflammable, thermally conductive fluid in electrical capacitors and transformers at PGDP. The large switchyards that service the process buildings included PCB-filled transformers. PCBs also have been used as flame retardants (on the gaskets of diffusion cascades in other sections of the plant), as a hydraulic fluid, and are used in paints on equipment that is subject to high temperatures. PCBs have been released to the environment from spill sites throughout the plant that resulted from specific transformer ruptures and as part of general operations over the years.

Uranium, thorium, and transuranic elements (i.e., plutonium and neptunium) were detected in off-site sediments near PGDP in 1988 (MMES 1989). Results ranged from approximately 2.5 to over 200 times background. Many of these sediments have been removed (Chapter 16) (DOE 2011a). Sources of uranium releases are general plant operations where uranium was washed into ditches and creeks.

3.4 INITIAL RESPONSE

After the discovery of groundwater contamination in 1988, DOE placed affected residences and businesses on an alternate water supply and began an intensive monitoring and investigation program to define the extent of contamination. DOE's first objective was to reduce immediate risks to off-site residents. DOE implemented plume control actions at the Northwest Plume Groundwater System and the Northeast Plume Containment System, and surface water institutional controls to reduce further the risks posed to human health and environment by releases from PGDP.

After addressing immediate off-site risks, DOE identified potential areas of contamination at PGDP (e.g., burial grounds, spill sites, and container storage areas) as SWMUs and areas of concern (AOCs). DOE then grouped most of the SWMUs and AOCs into WAGs, based upon common characteristics such as similar contaminants or type of media affected and gave highest priority to those WAGs with the greatest potential for contributing to off-site contamination. Subsequently, DOE began conducting response activities to address the contamination.

In August 1998, DOE, EPA, and the Commonwealth of Kentucky agreed to restructure the remedial strategy for PGDP. This restructuring reflects the accomplishment of sitewide remedial objectives through an OU approach based on the primary exposure pathways.

At PGDP, site cleanup will be implemented in a phased approach including cleanup activities that currently are being conducted prior to shutdown of the operating gaseous diffusion plant (pre-GDP Shutdown activities), followed by post-GDP Shutdown cleanup activities, and then by implementation of the Final Comprehensive Site OU (CSOU). Through implementation of these three phases, a series of prioritized response actions through which short-term protection goals, intermediate performance goals, and long-term final cleanup goals will be attained. Within this approach, the short-term protection goals are to control risks to humans and the environment; intermediate-term performance goals are to reduce, control, or minimize contaminants found in source areas; and long-term goals are to evaluate and pursue additional actions determined necessary to achieve the contaminant level reductions to provide long-term protectiveness. To achieve these goals, DOE and the regulatory agencies have agreed that PGDP cleanup activities will occur in a sequenced approach consisting of (1) pre-shutdown scope, (2) post-shutdown scope, and (3) CSOU scope. The pre-shutdown scope is associated with media-specific OUs initiated prior to shutdown of the operating GDP (pre-GDP shutdown activities). These media-specific OUs were established by developing a site conceptual risk model for each source area. This process included a qualitative evaluation of contaminant types and concentrations, release mechanisms, likely exposure pathways, estimated points of exposure, and potential receptors based on current and reasonably foreseeable future land groundwater uses. The source areas for the pre-GDP shutdown scope have been grouped into five media-specific OU as follows (DOE 2013a):

- D&D OU,
- GWOU,
- BGOU,
- SWOU, and
- Soils OU.

In addition to the response actions, each OU includes site characterization activities to support future response action decisions. The final action to support National Priorities List delisting will consist of the CSOU, which will evaluate residual risks and ensure all actions taken to date, when considered collectively, are protective of human health and the environment from a sitewide perspective. The timing and sequencing for implementation of activities associated with the OUs are based on considerations such as regulator expectations, risk-based decision making, compliance with other programs, technical considerations associated with GDP operations, mortgage reduction, and demonstrated progress toward completing the environmental management (EM) mission. Both the FFA and the Site Management Plan (SMP) (DOE 2013a) document the schedule of actions for the OUs.

The objective of grouping the sources and areas of contamination into these OUs is to provide a more comprehensive framework to assess sitewide risks, identify and prioritize response actions, and develop integrated cleanup solutions that will reduce any unacceptable risk across the primary exposure pathways through which human health and the environment may be affected. To support implementation of this strategy, the source areas and affected media within each OU have been subjected to a screening process to further segregate the source areas into various categories, including candidate areas designated as a high priority for a response action, areas requiring additional characterization/risk evaluation, and source areas associated with plant operations. Current examples of actions for high-priority areas include the ongoing implementation of the Water Policy; and the source action for TCE and other volatile organic compound (VOC) contamination at the C-400 Cleaning Building area, which is part of the GWOU.

In order to keep residents and the community informed of the remedial efforts taking place at PGDP, DOE established a Citizen's Advisory Board (CAB) in September 1996. This board is composed of people who reflect the diversity of gender, race, and interests of persons surrounding PGDP. The mission statement of the CAB, as stated in *Paducah Gaseous Diffusion Plant Citizens Advisory Board Operating Procedures* (Approved on October 21, 2010) is as follows:

> The mission of the Environmental Management (EM) Site-Specific Advisory Board (the Board or Citizens Advisory Board [CAB]) at the Paducah Gaseous Diffusion Plant (PGDP) is to provide meaningful opportunities for collaborative dialogue among the surrounding communities of the PGDP, EM, and the U.S. Department of Energy (DOE) Paducah Site Office (PSO). The Board is chartered under the EM Site-Specific Advisory Board Federal Charter. At the request of the Assistant Secretary or the Field Manager, the Board may provide advice and recommendations concerning the following EM site-specific issues: clean-up standards and environmental restoration; waste management and disposition; stabilization and disposition of non- stockpile nuclear materials; excess facilities; future land use and long term stewardship; risk assessment and management; and clean-up science and technology activities. The Board may also be asked to provide advice and recommendations on any other EM project or issue. The Board ensures early ongoing community access to information (and its interpretation and implications) and dialogue that improves the quality of the decision making process of EM.

The full CAB meets on odd numbered months to hear from persons working on relevant environmental efforts, listen to and discuss input from concerned citizens, form advice and recommendations to submit to DOE, and formulate recommendations to DOE about how to conduct clean-up actions. The CAB has working sessions on even numbered months. All meetings are open to the public in accordance with the organization's bylaws.

3.5 BASIS FOR TAKING ACTION

Exposures to soil, sediment, surface water, and groundwater are associated with risks that exceed EPA's risk management criteria either for industrial or residential exposure scenarios. Prior to implementation of the DOE Water Policy the risks were highest for exposures to contaminants in private wells. Other risks were due to recreational exposures in creek sediments and industrial exposures to process drainages. Additional information regarding the risks associated with potential areas of contamination at PGDP is included in the following sections.

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4. RESPONSE ACTIONS

The 13 sites with response actions that require Five-Year Reviews, the OU with which each site is associated, and the name used in the previous Five-Year Review are listed in Table 4.1. The location of the discussion of each action within this document is shown on Figure 4.1, the latest approved plume map, which shows the TCE plume based on 2010 data.

Table 4.1. Site/Project with Response Actions Taken at PGDP

Chapter	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
5.	Northwest Plume	GWOU	Northwest Plume
6.	Northeast Plume	GWOU	Northeast Plume
7.	Cylinder Drop Test Area or Lasagna™	GWOU	SWMU 91
8.	Water Policy	GWOU	Water Policy
9.	C-400 Electrical Resistance Heating	GWOU	GWOU C-400 Electrical Resistance Heating, currently underway
10.	Southwest Plume	GWOU	New to Five-Year Review, currently underway
11.	NSDD Source Control	SWOU	NSDD Source Control
12.	NSDD Sections 1 and 2	SWOU	NSDD Sections 1 and 2
13.	C-746-K Landfill	SWOU	WAGs 1 and 7, SWMU 8
14.	Fire Training Area	SWOU	WAGs 1 and 7, SWMU 100
15.	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
16.	Surface Water On-site Sediment Removal	SWOU	New to Five-Year Review
17.	C-749 Uranium Burial Ground	BGOU	WAG 22, SWMU 2

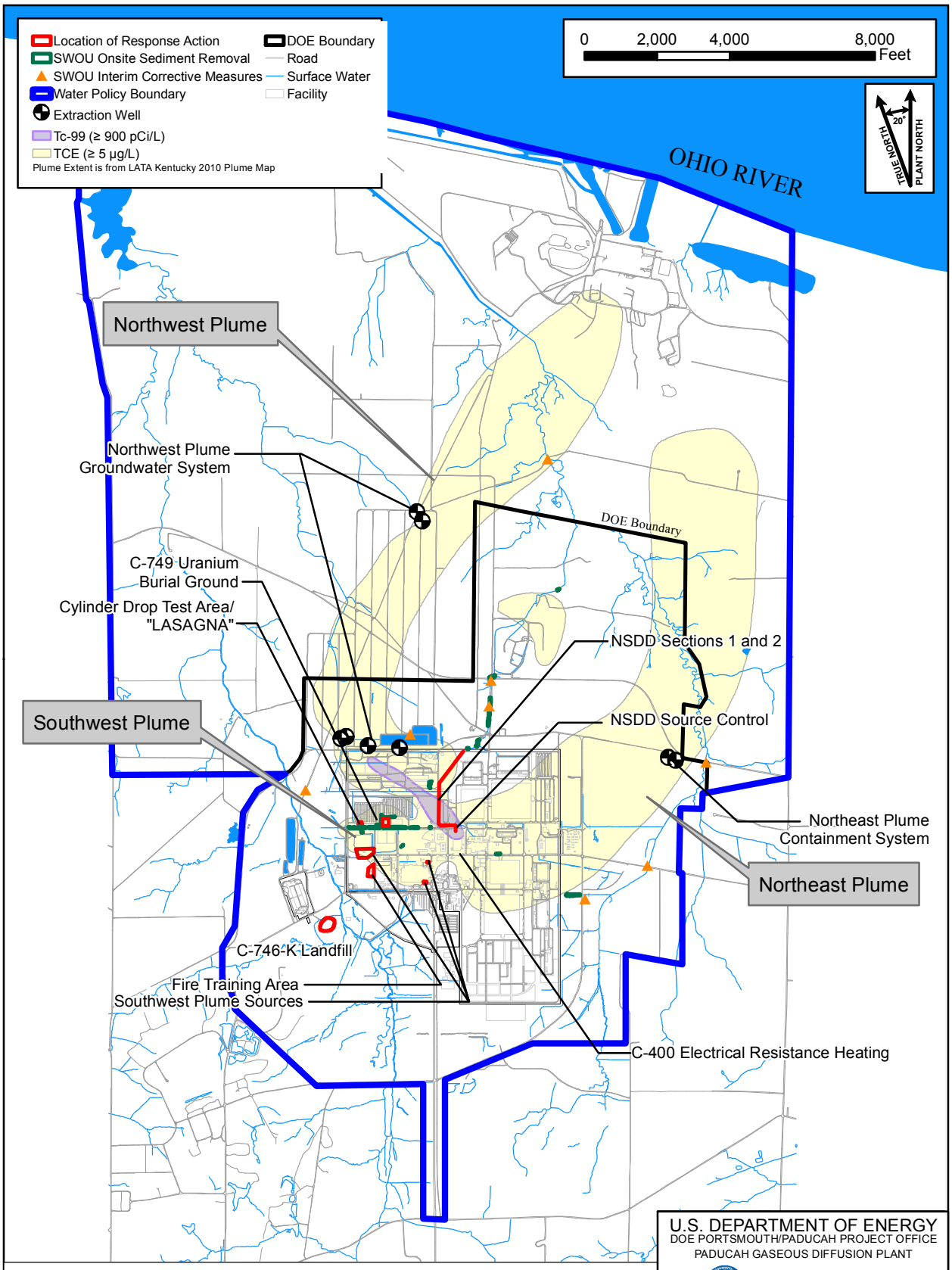

Figure 4.1. Locations of Response Actions Taken at PGDP

5. NORTHWEST PLUME

After the initial discovery of contamination at PGDP in August 1988, DOE conducted a site investigation (SI) to identify the nature and extent of the contamination. The investigation, documented in the *Results of the Site Investigation, Phase I, Phase II* (CH2M HILL 1991; CH2M HILL 1992), determined that the groundwater contamination is spreading generally northward toward the Ohio River in multiple plumes. The most prominent of the plumes, containing both TCE and Tc-99, is the Northwest Plume.

Outside of the immediate vicinity of its PGDP source areas on DOE Property, the Northwest Plume is restricted to the RGA, which occurs in a thick gravel unit and adjacent thin sands at depths of approximately 60 to 100 ft over most of the length of the plume. The extent of the Northwest Plume (and Northeast and Southwest Plumes) is well known through several DOE investigations. DOE maintains a monitoring well (MW) network to detect trends in the plume. The Northwest Plume underlies land controlled by the PGDP and the TVA Shawnee Fossil Plant and sparsely populated areas between the two reservations. Some contaminated groundwater from the Northwest Plume discharges in seeps in Little Bayou Creek on TVA property. The Ohio River is the regional discharge point for groundwater flow in the RGA.

The overlying soils consist of thick silt units with lesser interbedded sand and gravel deposits that isolate the plume from potential human and ecological exposure. The DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater through a license agreement process with landowners with private wells in the area of the plume, whereby DOE provides a household water supply to the area residents in return, which further limits any access to the contamination of the Northwest Plume.

Figure 5.1 illustrates the extent of the off-site Northwest Plume, the two EW fields which began operation in 1995 for the Northwest Plume Groundwater System (NWPGS), and an optimized EW field (consisting of two wells) which began operation in 2010. Figure 5.2 is a comparison of the plumes between 1994 and 2010, which is the latest available plume map (LATA Kentucky 2011). The downgradient limit of the Northwest Plume is near the Ohio River and at seeps in Little Bayou Creek.

The 2008 Five-Year Review had the following statement of protectiveness for the Northwest Plume IRA (DOE 2009a):

> The remedy for the Northwest Plume is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the dissolved-phase plume, need to be evaluated for long-term protection.

5.1 REMEDY SELECTION

EPA and DOE, with the concurrence of the Commonwealth of Kentucky, agreed to a ROD for an IRA for the Northwest Plume on July 22, 1993 (DOE 1993a). This IRA consisted of the installation and maintenance of two EW fields (consisting of four EWs) for a period of two years to initiate control of the high-concentration zone of TCE and Tc-99 in the Northwest Plume. A water treatment facility was constructed to treat effluent from the EWs. The Northwest Plume Groundwater System has continued to operate since August 1995.

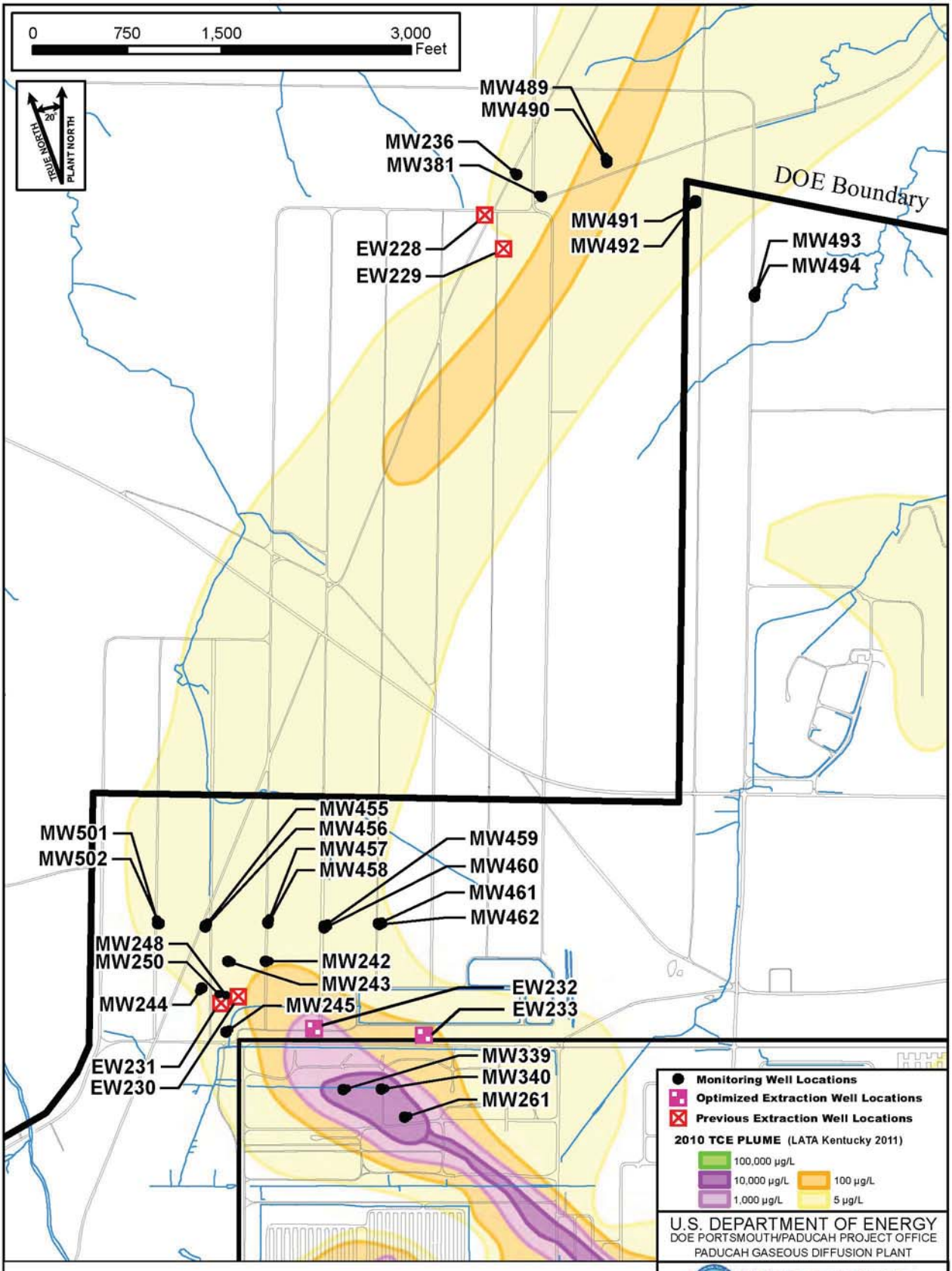

Figure 5.1. NW Plume EW Fields with 2010 TCE Plume Map

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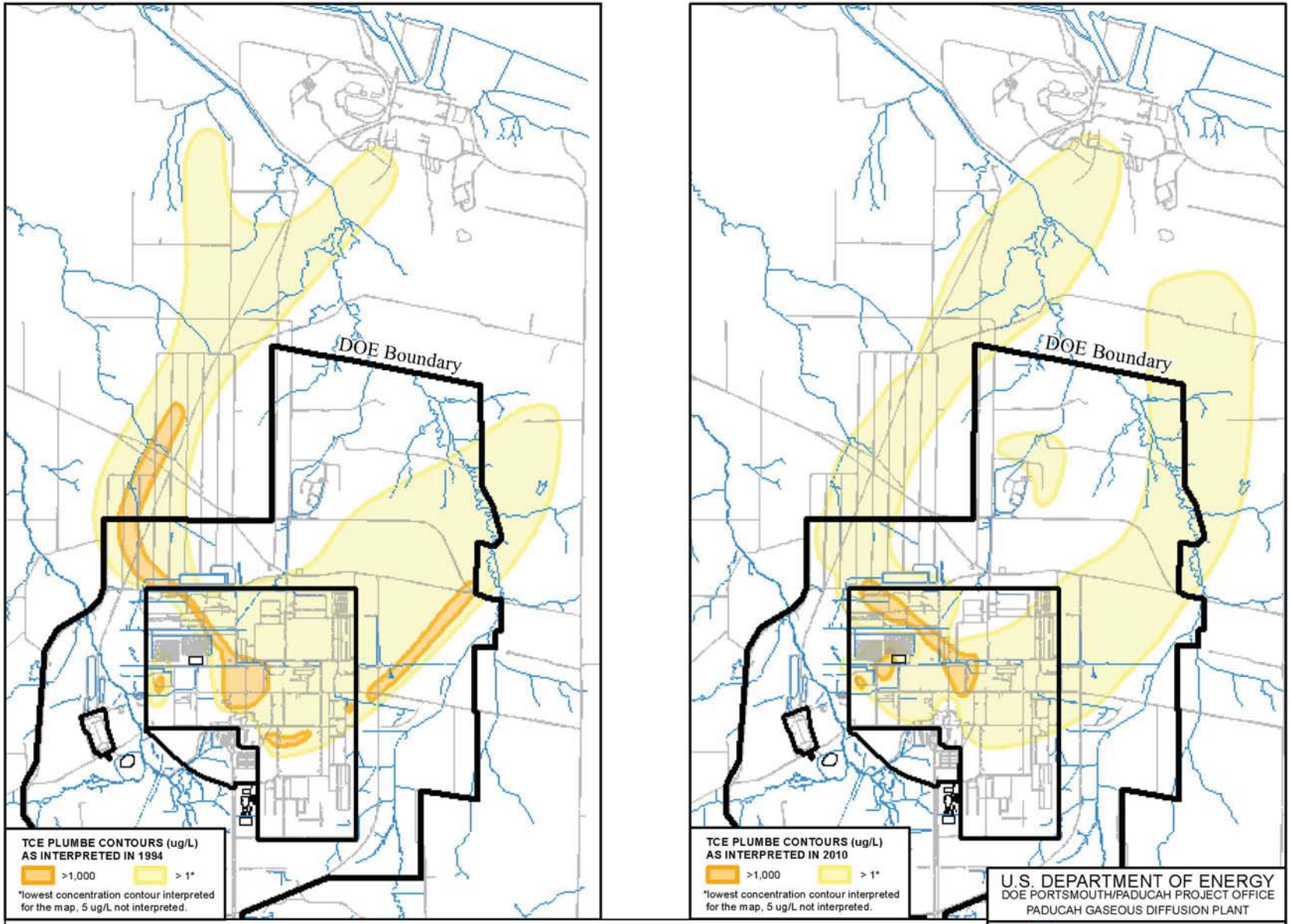

Figure 5.2. TCE Plumes as Interpreted for 1994 and 2010

The *Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* delineated the remedial action as follows (DOE 1993a):

> The contaminated groundwater will be extracted at two locations. The first location, immediately north of the plant on DOE property, is intended to control the source. The second groundwater extraction location is off-site of the DOE reservation at the northern tip of the most contaminated portion of the plume [greater than 1,000 µg/L of trichloroethylene (TCE)]. The contaminated groundwater will be pumped at a rate to reduce further contribution to contamination northwest of the plant without changing hydraulic gradients enough to mobilize dense nonaqueous-phase liquids (DNAPLs) or significantly affect other plumes. This pumping rate may be modified during operation to optimize hydraulic containment by adjusting flow from the extraction wells and to support subsequent actions.
>
> The extracted groundwater will be collected in a manifold and piped to the treatment system, which will consist of two ion exchange units in parallel followed by an air stripper with treatment for off-gas emissions. This technology provides the treatment to the COCs (TCE and Tc-99). The target level for treatment of TCE is 5 ppb and 900 pCi/L for Tc-99.
>
> The amount of treated water discharged will be limited by the flow capacity of the skid mounted treatment units. The treated water will be discharged through KPDES permitted Outfall 001.
>
> The interim action also includes implementation of a treatability study to evaluate an innovative technology. The innovative technology to be studied involves the potential utilization of iron filings as a viable alternative to pump-and-treat technology for groundwater treatment.
>
> The remedy does not address source remediation, however; the remedy will address continuing release from a DNAPL principal threat source area.

Cleanup levels and RAOs are not specifically stated because the principal goal of this interim action is to decrease the risk by mitigating the spread of the high concentration portion of the Northwest Plume, retarding the migration of the contaminants emanating from the source area.

5.2 REMEDY IMPLEMENTATION

The remedial design and remedial action work plan (RAWP) was issued in May 1994 (DOE 1994a). The construction of the facility was performed in two phases. The first phase was the installation of MWs and EW fields. The second phase of work was the installation of the treatment facility and all internal equipment, as well as subsurface pipelines to transport the contaminated water through the WKWMA to the treatment system. All of the construction was completed in May 1995, with calibration and operational preparedness through August 27, 1995. The NWPGS began pump-and-treat operations on August 28, 1995.

The interim action, as installed, included the following:

- Four EWs and associated monitoring network with two EWs located at the north end of the high concentration zone and two EWs located immediately north of the plant;

- Double-walled subsurface pipelines with leak detection equipment to transport the contaminated water to the treatment facility;

- Active treatment equipment located in the facility including an equalization (EQ) tank, dual sand filter unit, low-profile air stripper, two double ion exchange units, and on-line volatile organic analyzer; and

- Support equipment installed in the facility including backwash, settling tank, sludge handling equipment, air compressor, and filter press.

DOE issued an *Explanation of Significant Differences for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1481&D2, in August 1996 that proposed modifying the original remedial action (DOE 1996a). The three propositions in the document were as follows: (1) elimination of the activated carbon filters, (2) reversal of the sequence of the two treatment units (ion exchange unit and air stripper), and (3) elimination of the iron filings treatability study (DOE 1996a). At that time, DOE determined that the remedy would remain protective of human health and the environment and would meet the applicable or relevant and appropriate requirements (ARARs) identified in the ROD and additional ARARs introduced by the modifications. The additional ARARs triggered by the reversal of the treatment units are identified in the Explanation of Significant Differences document, approved by EPA on November 18, 1996. The Northwest Plume remedial action continues to comply with these ARARs. Although removing the carbon filters would not result in violation of Clean Air Act standards, DOE withdrew its proposal to eliminate the carbon filters in response to public comments.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at PGDP. The Sitewide Remedy Review report recommended that DOE expand the monitoring and characterization program, provide for an independent assessment to optimize the Northwest Plume and Northeast Plume IRAs, and further evaluate natural attenuation processes. At the request of DOE, the U.S. Army Corps of Engineers led a Remediation System Evaluation of the Northeast and Northwest Plume Extraction Systems at PGDP during October 2006. The review team concluded that the Northwest Plume IRA should be modified to terminate extraction at the two northern EWs and increase total extraction in the vicinity of the southern EWs. The strategies to increase extraction near the south wellfield included the addition of extraction locations to the east of the original EWs.

The 2008 Five-Year Review had the following recommendation:

> Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.

In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS initially consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and

EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and will be returned to service, if needed. The location of the new EWs was optimized to enhance mass capture of the Northwest Plume in the area of the north plant boundary through EW placement and increased extraction capacity. Each of the two new EWs can pump 220 gpm, if required, which is the throughput capacity of the C-612 treatment facility. This allows the optimized EWs to be operated separately or together as needed in response to potential changes in plume trajectory resulting from changes in site flow conditions.

DOE issued *Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0339&D1 (DOE 2010a) in May 2010 to document the groundwater flow modeling used in the optimization approach and revisions to wellfield design and to establish a testing and monitoring program for the new EW field. Major construction for the optimization of the Northwest Plume Treatment System was completed on August 13, 2010. Following completion of construction, the system underwent testing and was commissioned on August 27, 2010, transferring the system to routine operation and maintenance.

Revision of *Operations and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1253&D4/R5 (DOE 2010b) was completed in September 2010 and a hydraulics test of the new EW field was performed in October 2010. DOE issued *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2 (DOE 2010c) in December 2010 to describe the response action optimization that is expected to result in more effective control of contaminant migration from the source area. DOE followed with the *Postconstruction Report for the Northwest Plume Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0359&D1, (DOE 2011b) in January 2011.

5.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Operations and maintenance (O&M) for the NWPGS are conducted in accordance with the *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2010b). Routine and preventive maintenance has been conducted in accordance with the *Paducah Plume Operations Maintenance, Calibration, and Testing Plan* (LATA Kentucky 2012a).

Since initial operations, the frequency of repair to the system has been normal and routine. The Northwest Plume treatment system had processed 1,756,903,636 gal of water, as of December 31, 2012. Mass balance evaluations indicate that the treatment system has removed approximately 34,766 lb (2,871 gal) of TCE.

The costs associated with the O&M of the NWPGS and the Northeast Plume Containment System (separate GWOU action discussed in Chapter 6) are tracked jointly and have been since fiscal year (FY) 2002. The cost for both systems for the five-year reporting period is $3.42M, or an average of $6.84K per year. The total operation cost for both the NWPGS and the Northeast Plume Containment System was $28.6M by the end of December 2012.

No major modifications to the treatment system were made during this reporting period (i.e., replacement of primary equipment). The activated carbon units are changed routinely due to contaminant loading. Only infrequent replacement of the ion exchange resin is required. The two lag ion exchange columns

were changed out in April 2010; the two lead columns last were changed in April of 2004. Beginning in August 2010, the NWPGS switched from withdrawal from the original four EWs (with a combined withdrawal of approximately 220 gal/minute) to withdrawal from two new EWs (operating at a pumping rate of approximately 110 gal/minute each).

On January 17, 2013, the Northwest Plume Pump-and-Treat Facility was inspected for this Five-Year Review. The facility includes the C-612 Treatment Facility and the south wellfield (EW232/EW233). The treatment facility is located just outside the northwest corner of the perimeter fence of PGDP, but within the security buffer zone around the plant. The EW232/EW233 Field is located east of the treatment facility (just north of the PGDP perimeter fence and within the security buffer zone) and close to the C-616-E and C-616-F lagoons.

The C-612 Treatment Facility is a pre-engineered metal building with one vehicular entrance and two pedestrian entrances. The exterior of the building appears in good condition with no signs of damage, rust, or deterioration. The area around the building is maintained well, including mowing and weed trimming. A chain-link security fence that is in good condition encloses the building.

All treatment process equipment is located within the building. Groundwater treatment equipment inside includes a sand filter unit, an air stripper and carbon filtration unit, and four ion exchange columns. The interior of the building is clean, free of clutter and debris, and maintained well. Access-controlled areas within the building are clearly marked and identified. Process piping in the facility is identified properly as to content and flow direction, adequately supported, and in a well-maintained condition. There were no signs of leaks or deterioration. Process control panels are maintained well with all components clearly identified and labeled. All electrical power and control panels are labeled properly. The building contains a wet-type fire sprinkler system that is monitored constantly via a supervisory control and data acquisition (SCADA) system by the PGDP Fire Services Department.

The Northwest Plume IRA treatment system has continued to operate as intended during the 2008–2012 period.

5.4 TECHNICAL ASSESSMENT

The primary objective of the Northwest Plume IRA is to initiate an action to mitigate the spread of the high concentration zone of TCE and Tc-99 contamination of the Northwest Plume. Monitoring data indicate that this remedial action is significantly reducing contaminant concentrations in the Northwest Plume. The action described in the ROD is not intended or expected to return groundwater quality to maximum contaminant levels (MCLs).

The original north and south EW Fields operated nearly continuously since the start of pumping on August 28, 1995 through August 27, 2010, when operation of the new south EW field (EW232 and EW233) began. Influent and effluent monitoring of the aboveground groundwater treatment system shows that the treatment system is effectively reducing the contaminant levels of the extracted water to target levels that are approved for release to surface water.

Figure 5.3 shows contaminant level trends in each of the south EWs. Targets for the average levels of TCE and Tc-99 in effluent continue to be met as indicated from the latest semiannual reporting period of January 2012 to June 30, 2012 (Table 5.1). The target concentrations for these contaminants are 5 µg/L EW230 and EW231, the EWs of the original south wellfield, are kept in standby mode and will be returned to service, if needed.

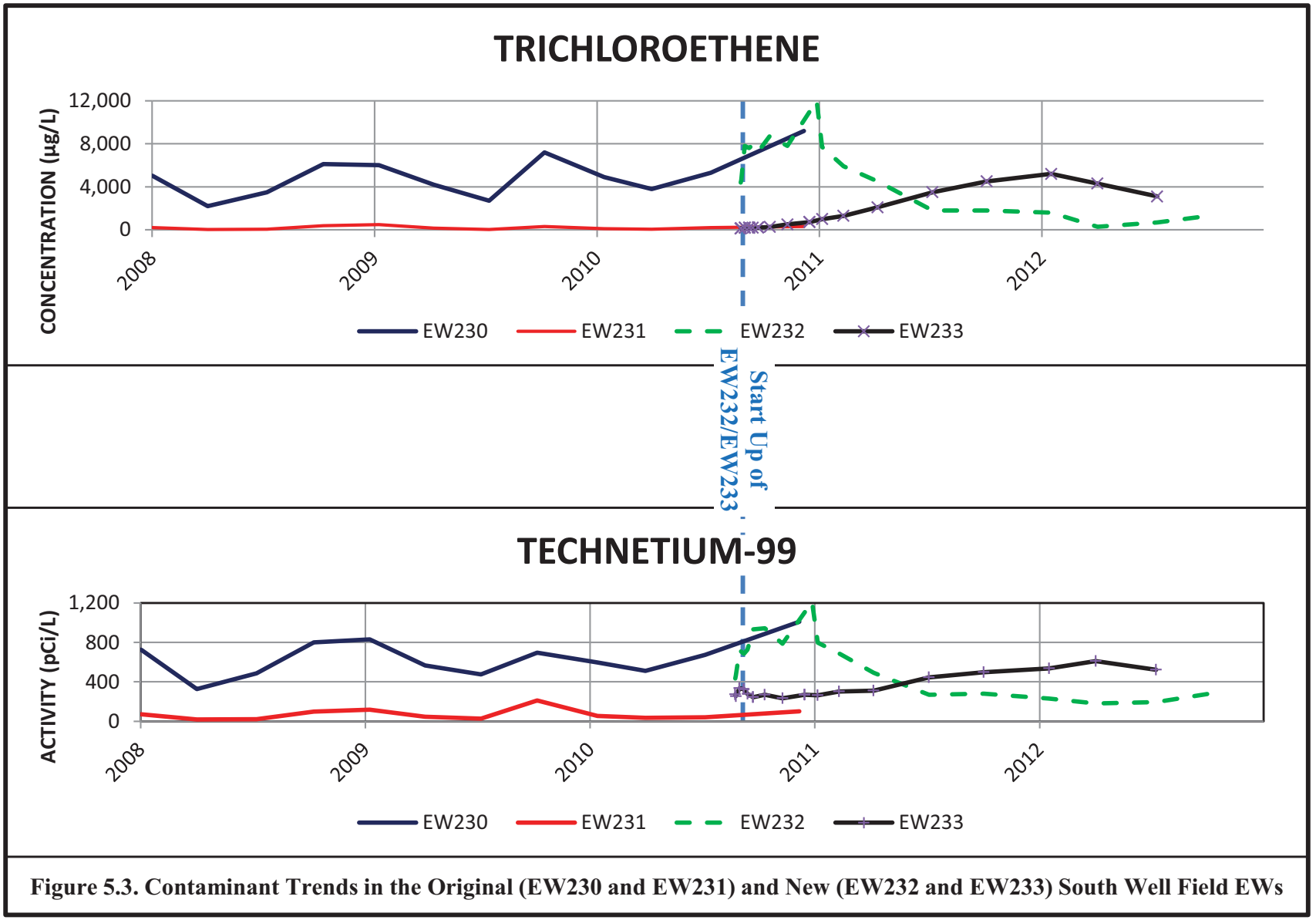

Figure 5.3. Contaminant Trends in the Original (EW230 and EW231) and New (EW232 and EW233) South Well Field EWs

Table 5.1. Northwest Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)			Tc-99 (pCi/L)		
	High	**Low**	**Average[a]**	**High**	**Low**	**Average[a]**
Influent	2,700	2,100	2,422	412	342	365
Effluent	6.6	2.5	4.15	43.3	16.3	28.3

Data is taken from the DOE PGDP FFA Semiannual Progress Report for Fiscal Year 2012 (DOE 2012a).
[a] Average is calculated as an arithmetic average, using the laboratory reporting limit for nondetects.

Groundwater flow modeling for the optimization study predicted 99.99% capture of the mass of TCE flux in the Northwest Plume at the PGDP security fence using the two new EWs that were installed in 2010. Groundwater analyses for TCE and Tc-99 from the MW systems for the original south EW Field (EW230 and EW231) and for the new south EW field (EW232 and EW233) demonstrate that the EWs have reduced contaminant levels in the RGA and that these reduced levels persist.[1] Table 5.2 summarizes contaminant analyses for late 1995, when groundwater extraction began at EW230 and EW231, compared with 2012 levels. Figure 5.4 shows the trends in TCE and Tc-99 in the two wells of the original south wellfield with highest contaminant levels (MW243 and MW248).

Table 5.2. Summary of Contaminant Levels at the Original South EW Field (EW230 and EW231)

	TCE Concentration (µg/L)		Reduction in	Tc-99 Activity (pCi/L)		Reduction in
Well	**Late 1995**	**2012**	**Concentration**	**Late 1995**	**2012**	**Activity**
MW242	530	120-160	Yes	247	197-218	Yes[a]
MW243	13,500	30-53	Yes	3,781	ND[b]-38	Yes
MW244	3,600	3-10	Yes	1,048	ND	Yes
MW248	14,000	9-28	Yes	3,488	ND-33	Yes
MW250	13,300	4-21	Yes	3,358	ND	Yes
MW245[c]	28	89-130	No	24	ND	Yes

[a] Tc-99 levels have declined through 2007, but have increased over the period 2008 through 2012.
[b] Nondetect
[c] Upgradient well

For the years 1998 through 2012, MW261, MW339, and MW340, located in the core of the Northwest Plume and far upgradient of both the original and new south EW fields, EW230/231 and EW232/233 (see Figure 5.1), have continued to yield water with elevated levels of TCE (as much as 10,000 to 40,000 µg/L) and Tc-99 (as much as 1,500 to 6,000 pCi/L) (see Figure 5.5). Marked trends of declining contaminant levels in MW261 and MW339 and increasing trends in MW340 (Figure 5.6) illustrate the eastward migration of the core of the upgradient plume. The rate of eastward migration may increase with continued operation of the new south EW232/233 wellfield. Downgradient MWs for the new south EW232/233 wellfield document significantly reduced contaminant levels (Figures 5.7 and 5.8) and suggest that the new EW field is reducing contaminant levels in the core of the Northwest Plume, as intended by the ROD.

DOE performed a MW upgrade project during the period October 2009 through February 2010, which resulted in the installation of 38 new MWs in the area of the Northwest Plume. A membrane interface probe (MIP) was used to characterize the location of the centroid of the Northwest Plume along four transects and optimize the location of many of these wells. Results of a MIP transect to the east of the north wellfield which began operation in 1995 (EW228/EW229 wellfield) documented that the centroid

[1] Contaminant trends in MW242, specifically Tc-99 after late 2007, are less persuasive. Rising Tc-99 levels in MW242 after late 2007 may reflect an eastward migration of the Northwest Plume and the location of the core of Tc-99 contamination on the east side of the Northwest Plume.

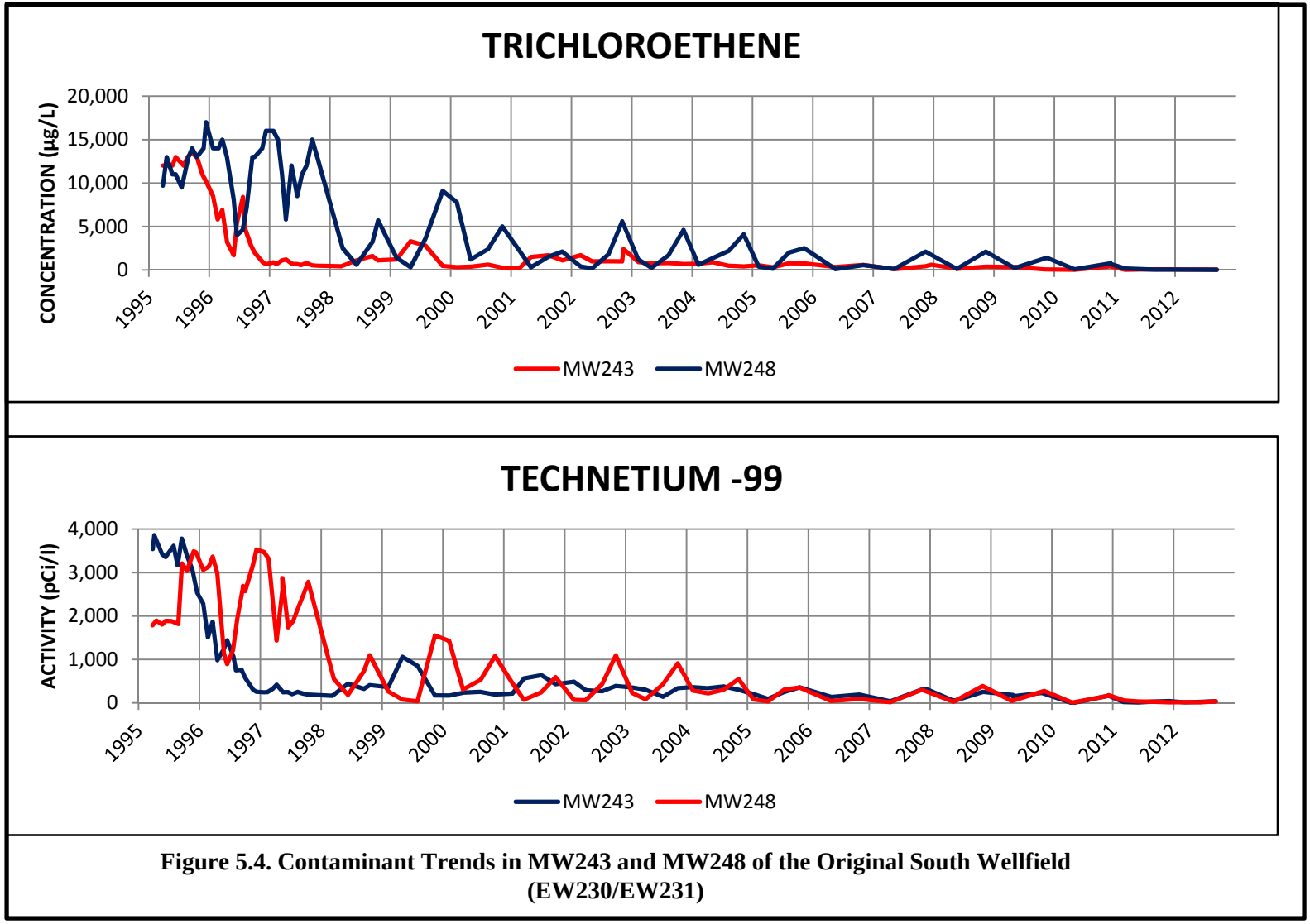

Figure 5.4. Contaminant Trends in MW243 and MW248 of the Original South Wellfield (EW230/EW231)

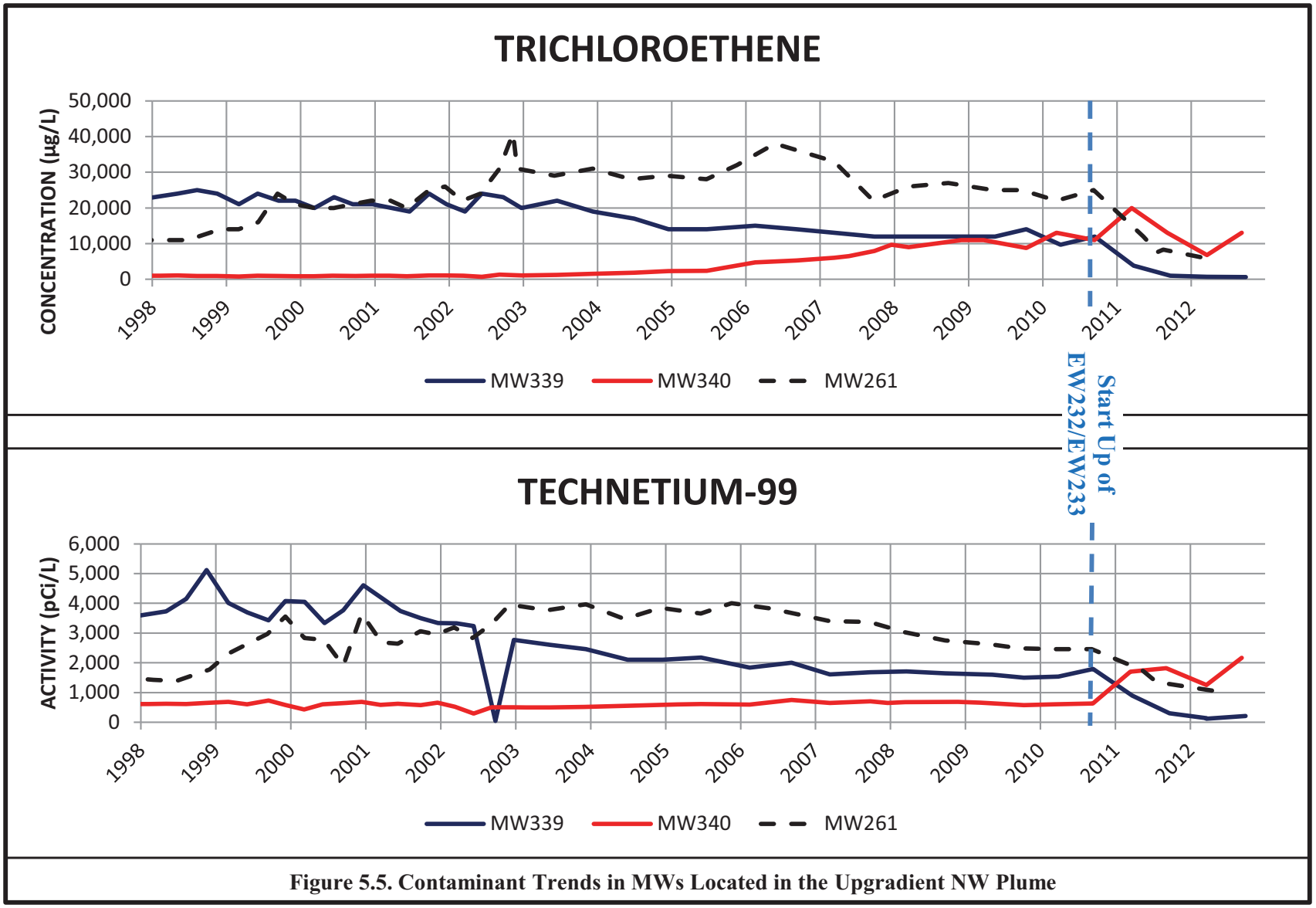

Figure 5.5. Contaminant Trends in MWs Located in the Upgradient NW Plume

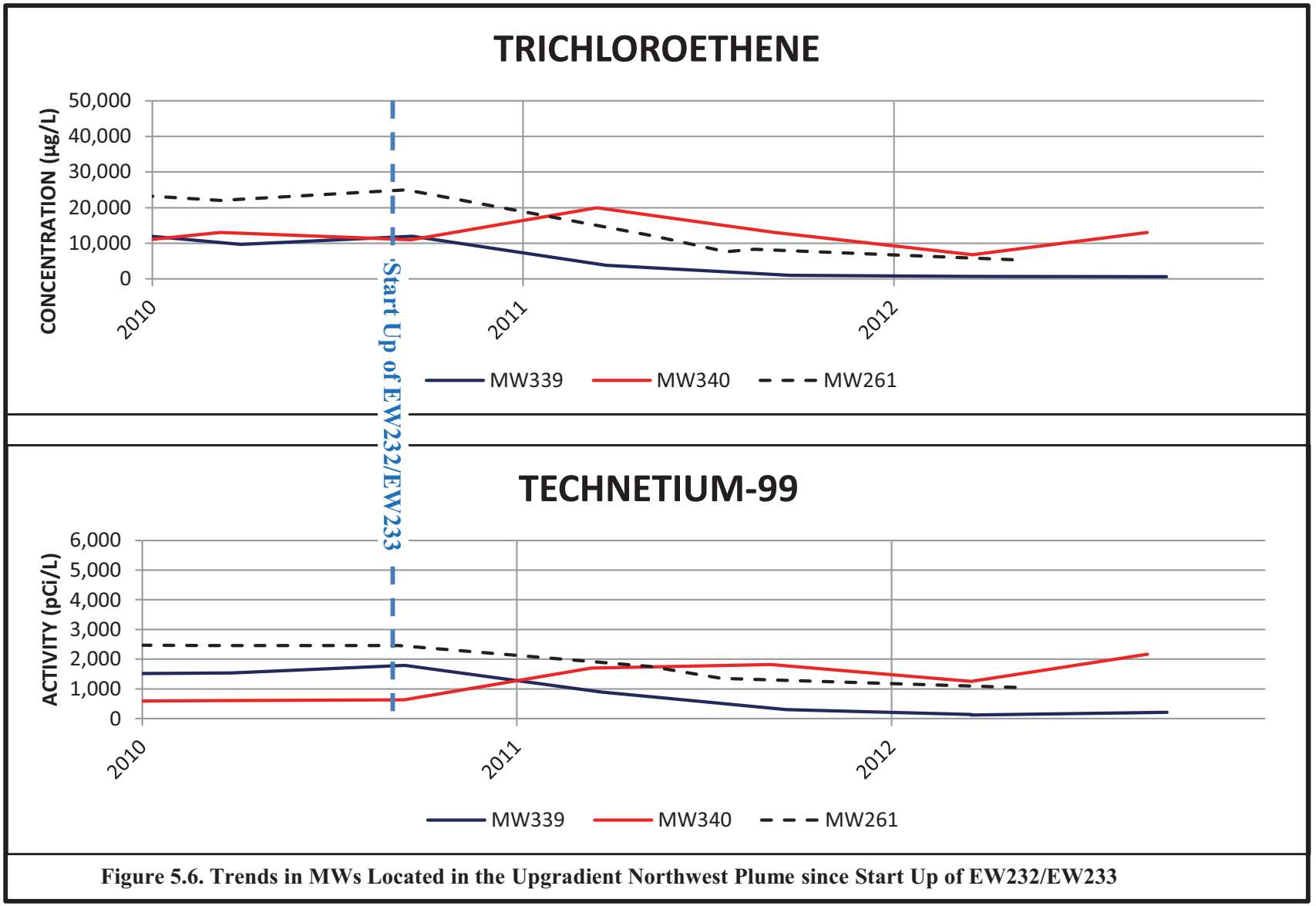

Figure 5.6. Trends in MWs Located in the Upgradient Northwest Plume since Start Up of EW232/EW233

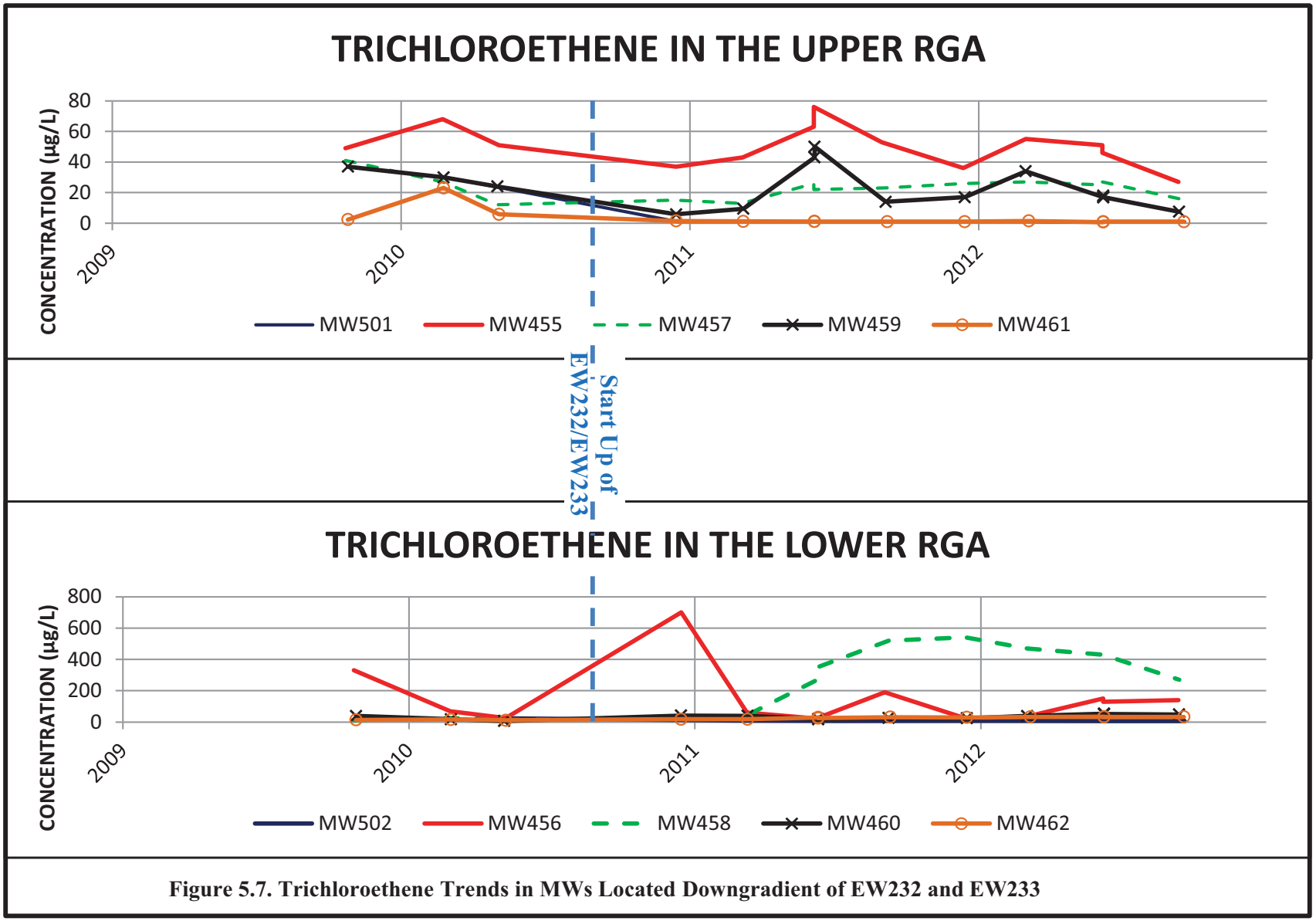

Figure 5.7. Trichloroethene Trends in MWs Located Downgradient of EW232 and EW233

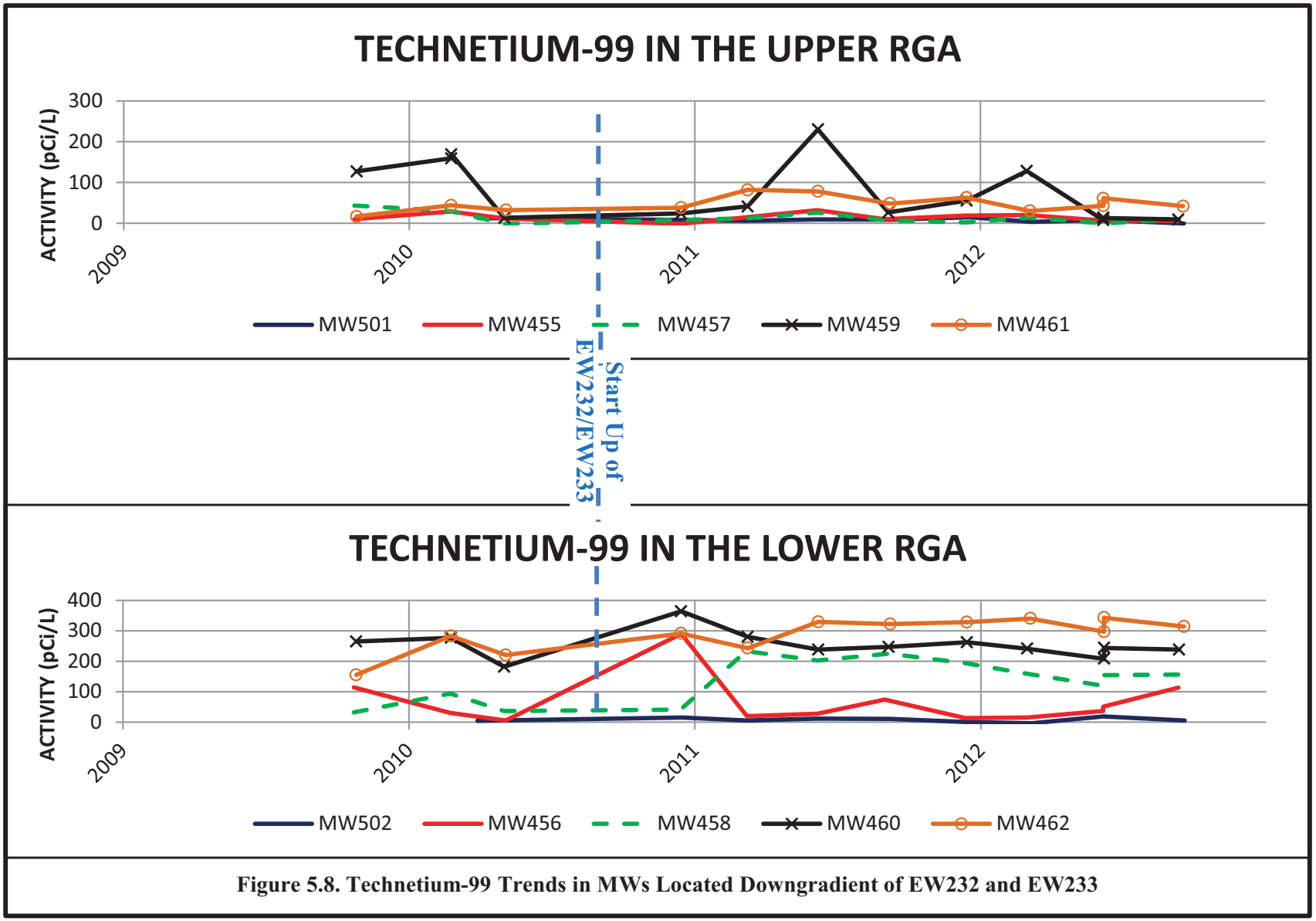

Figure 5.8. Technetium-99 Trends in MWs Located Downgradient of EW232 and EW233

of the Northwest Plume had migrated to the east of the EW228/EW229, north wellfield. RGA MW cluster MW489/MW490 was placed in the centroid of the Northwest Plume and MW cluster MW493/MW494 was placed to the east of the centroid. Together with MW381 (now located on the west side of the centroid, the analyses of groundwater samples from these wells document the contaminant trends in the area of the former north wellfield.

Operation of the new south EW field (EW232/EW233) has significantly increased the extent of the capture zone in the Northwest Plume near the north PGDP security fence. In general, contaminant levels in the core of the Northwest Plume in the area of the north wellfield have declined: in 2012, contaminant levels are 200 µg/L or less TCE and 102 pCi/L or less Tc-99. Table 5.3 and Figure 5.9 document the contaminant trends in the area of the north wellfield.

Table 5.3. Summary of Contaminant Levels in the Area of the North EW Field (EW2228 and EW229)

		TCE Concentration (µg/L)			Tc-99 Activity (pCi/L)		
Well	**Screen Interval**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
MW236	lower RGA	27	12	N/A[a]	28	ND[b]	N/A
MW381	middle RGA	46	N/A	N/A	27	N/A	N/A
MW489	upper RGA	200–310	220–310	150–200	95–111	76–111	57–61
MW490	lower RGA	320–530	170–320	150–200	141–153	62–122	63–71
MW491	upper RGA	13–20	3–160	100–110	91–110	81–99	87–99
MW492	lower RGA	28–47	8–130	130–140	91–103	84–109	98–102
MW493	upper RGA	4	3-4	2-3	11-30	10-30	14-32
MW494	middle RGA	6	4	ND-3	ND-15	20-46	25-42

[a] Data not available—no sample collected.
[b] Nondetect

The thick interval of relatively low-permeability silt that overlies the Northwest Plume should reduce the potential for transport of VOC vapors from the Northwest Plume to the surface. Moreover, the NWPGS has significantly reduced VOC levels in the off-site plume and is anticipated to further reduce off-site contaminant levels with continued operation. While operation of the NWPGS is an interim action with no established cleanup levels, the NWPGS is effectively protective in conjunction with other PGDP actions (notably the Water Policy, discussed in Chapter 8).

5.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. Reviews of documents, groundwater monitoring data, and the results of the site inspection all indicate the following about the Northwest Plume Extraction System:

The EW Fields are functioning by retarding the migration of contaminants emanating from the source area; therefore, its function is consistent with the objective in the ROD. The treatment system is functioning as designed.

5.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

PGDP's Northwest Plume underlies land controlled by DOE and the TVA Shawnee Fossil Plant and sparsely populated areas between the two reservations. DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater in the area of the plume through a license agreement process with landowners and by providing household water supply to the area residents. Exposure assumptions used in the ROD regarding future domestic use of groundwater off DOE property remain

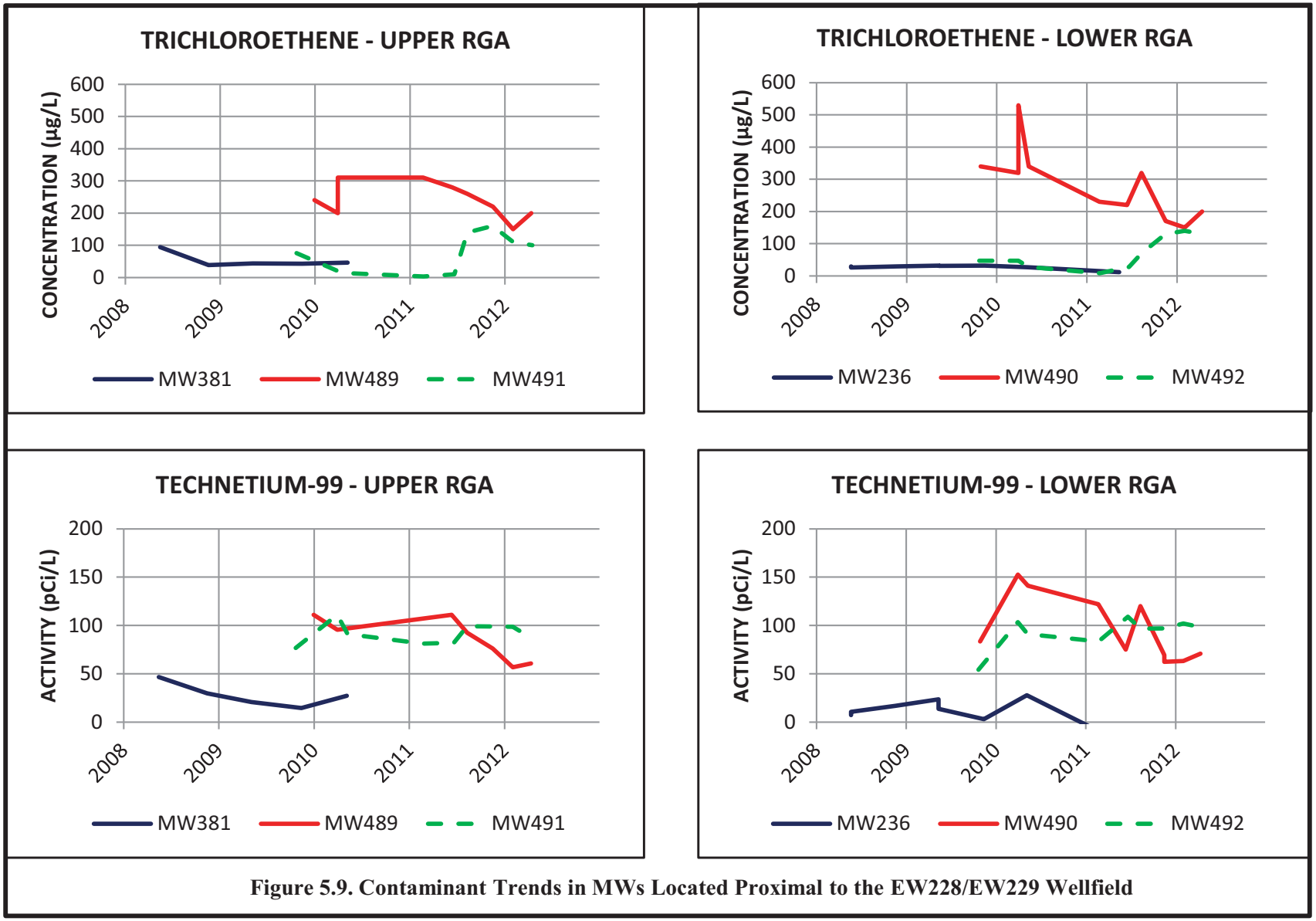

Figure 5.9. Contaminant Trends in MWs Located Proximal to the EW228/EW229 Wellfield

valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

The exposure assumptions used to develop the Public Health and Ecological Assessment (PHEA) included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker). The MCL for TCE remains 0.005 mg/L as it was during the original remedy selection; however, the original remedy was based on the assumption that there is no exposure pathway because institutional controls prevent access to the contaminated groundwater. The changes to the parameters for risk evaluation of TCE, therefore, have no effect on the protectiveness of the remedy because the exposure assumption (no exposure) is still valid.

Cleanup levels and RAOs are not specifically stated because the principal goal of this interim action is to decrease the risk by mitigating the spread of the high concentration portion of the Northwest Plume, retarding the migration of the contaminants emanating from the source area.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in the ARARs identified as to be considered (TBC) in the ROD that impact the protectiveness of the remedy.

5.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

5.4.4 Technical Assessment Summary

The operational data and the site inspection indicate that the mechanical components of the remedy are functioning as intended by the ROD.

The Northwest Plume IRA now consists of groundwater extraction at one location immediately outside the north PGDP industrial area. This EW field is intended to control the source of groundwater contamination to the Northwest Plume immediately north of the PGDP main plant boundary. Contaminant levels in the area of the previous north EW field (EW228/EW229) have significantly decreased since the initiation of the Northwest Plume IRA and are continuing to decline with the operation of the new EW field (EW232/EW233). The remedy remains protective.

5.5 ISSUES

None.

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6. NORTHEAST PLUME

After the initial discovery of contamination at PGDP in August 1988, DOE conducted a site investigation to determine the extent of contamination. The investigation, documented in the *Results of the Site Investigation, Phase I, Phase II* (CH2M HILL 1992), determined that the groundwater contamination is spreading generally northward toward the Ohio River in multiple plumes. Results of a follow-up groundwater monitoring investigation presented in the *Northeast Plume Preliminary Characterization Summary Report* delineated numerous plumes within the RGA that coalesce to form the Northeast Plume (DOE 1995a). One of these plumes was a zone of high TCE concentration (TCE concentrations exceeding 1,000 µg/L) that emanates from the eastern portion of the plant and extends off DOE property. Figure 6.1 depicts the aerial extent of the Northwest and Northeast plumes based on the latest approved plume map from 2010 (LATA Kentucky 2011).

The 2008 Five-Year Review states the following:

> The remedy for the Northeast Plume is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled.

6.1 REMEDY SELECTION

Because of the risks related to off-site migration from on-site contaminant sources, DOE initiated an IRA for the Northeast Plume. DOE signed the Northeast Plume ROD June 13, 1995; EPA signed June 15, 1995 (DOE 1995b). KDEP conditionally concurred with the selected remedy June 5, 1995. The ROD identified the selected remedy, outlined the performance objectives, and provided rationale for the remedy selection. The ROD stated the objectives as follows: "Implementation of this interim remedial action will (1) initiate hydraulic control of the high concentration area of TCE contamination within the Northeast Plume that is migrating outside the eastern margin of the plant security fence, and (2) monitor the performance of this interim remedial action in order to track contaminant migration and assess the system's performance prior to development of a final remedy."

The major components of the selected RA included the following:

- Installation of extraction wells and pumps that were to be located at the northern end of the high-concentration TCE portion of the Northeast Plume. At the time of the ROD's preparation, the high-concentration portion had a TCE concentration greater than 1,000 µg/L. The pumping rate selected in the ROD was approximately 100 gal per minute, which was enough to initiate hydraulic control, but not change groundwater gradients.

- Implementation of a treatment system that consisted of process water cooling towers that already were located at PGDP and would be used to volatilize the TCE and 1,1-dichloroethene (DCE) before the treated water was discharged to KPDES Outfall 001. The water was to be collected and pumped to the top of the tower and trickle down over slats that increased the surface area of the water and transit time spent in contact with the atmosphere. This resulted in volatilization of contaminants, while the temperature of the water approached that of the ambient atmosphere.

- Two treatability studies also were included to evaluate the use of photo catalytic oxidation for the treatment of TCE in vapor phase and *in situ* treatment of TCE-contaminated groundwater.

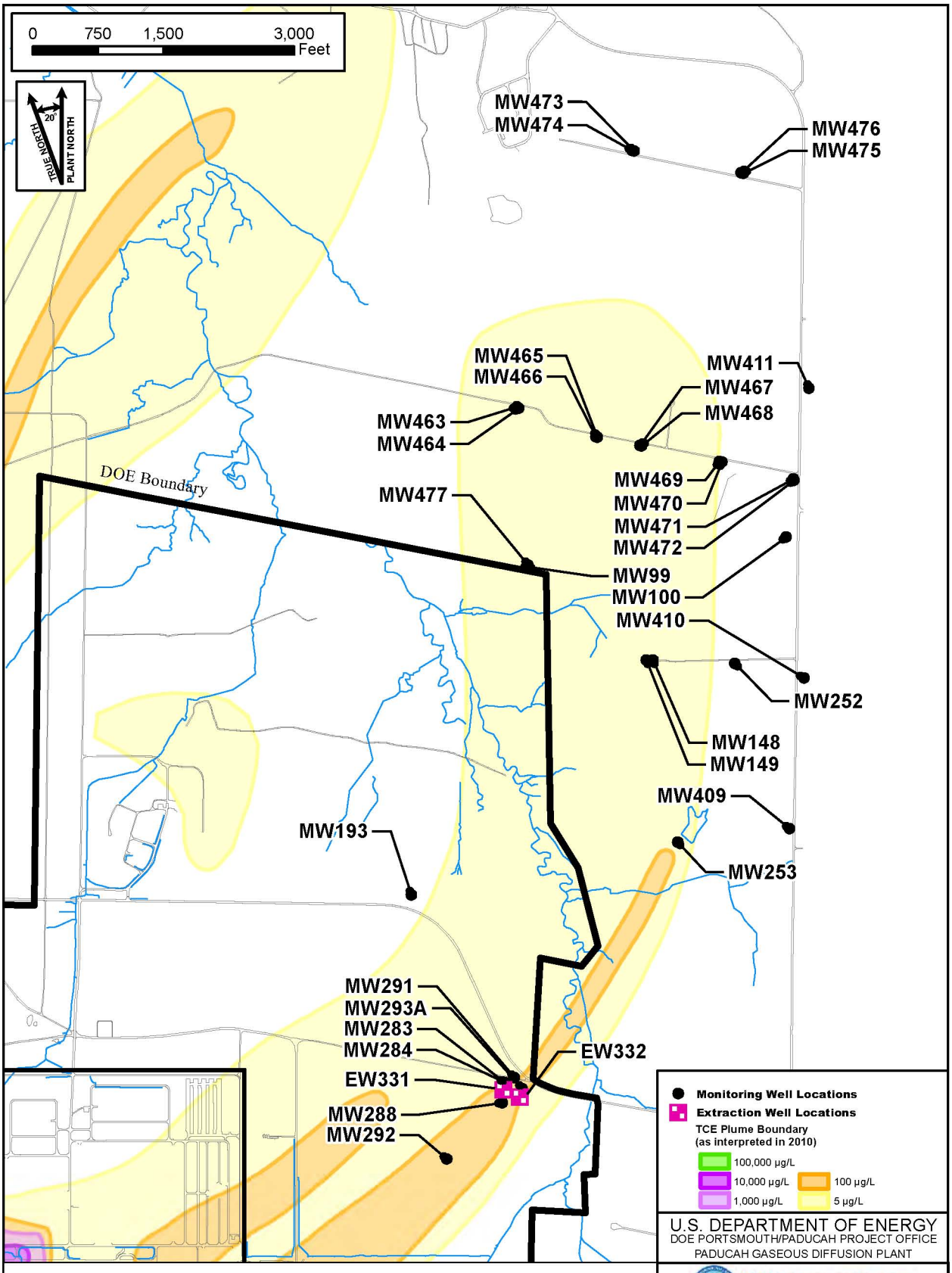

Figure 6.1. NE Plume EW Field with 2010 TCE Plume Map

FIGURE No. NE Plume\NEPlume_EW_Field_R1.mxd
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The Northeast Plume ROD documents the goal as follows:

> The primary objective of this interim remedial action is to implement a first-phase remedial action as an interim action to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the plant security fence.

The ROD was supported by a PHEA. In the PHEA, TCE is listed as the primary PGDP-related contaminant found in groundwater off DOE property. The *Summary of Comparative Analysis of the Interim Alternatives* (Section 2.8 of the ROD) discusses risk relative to nearby communities and workers associated with the construction and operation of the source control systems.

6.2 REMEDY IMPLEMENTATION

Following the signing of the ROD on June 15, 1995, DOE began the remedial design process for the selected remedial alternative. Minor modifications to the remedial action were required during the design phase. These minor modifications included the following:

- Removing the sand filter,
- Adding an EQ tank,
- Increasing pumping rate from 100 gpm to 170 gpm, and
- Postponing indefinitely the two treatability studies.

The rationale for removing the sand filtration system was based on the lack of suspended solids in the groundwater. Should suspended solids increase, the current treatment system configuration would allow for addition of a sand filter. No sand filter has been needed to date. An EQ tank was added to equalize water flow. Currently, the average pumping rate for the Northeast Plume EWs is approximately 200 gpm.

DOE issued a Notice to Proceed with construction April 5, 1996, and construction of the Northeast Plume pump-and-treat system was completed in December 1996. Major equipment installed for this project included two EWs capable of producing a combined maximum discharge of 260 gpm, a 20,000-gal underground fiberglass-reinforced plastic EQ tank, and a submersible transfer pump capable of producing a maximum discharge of 263 gpm. This process equipment was installed along with associated piping, valves, and fittings. The construction of the facilities was documented in the *Postconstruction Report for the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant*, Paducah, Kentucky, and was issued February 7, 1997 (DOE 1997a). The postconstruction report presents the summary of the construction activities for the RA. Operation of the Northeast Plume IRA began February 28, 1997.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at PGDP. The Sitewide Remedy Review report recommended optimization of the Northeast Plume and Northwest Plume IRAs. At the request of DOE, the U.S. Army Corps of Engineers led a Remediation System Evaluation of the Northeast and Northwest Plume Extraction Systems at PGDP during October 2006. The review team concluded that the interim goal of the Northeast Plume IRA, to control migration of water contaminated by > 1,000 μg/L TCE, had been achieved. The review team's main recommendation concerning the Northeast Plume IRA was that the system be placed in standby mode, with continued detection monitoring to assess the potential reappearance of TCE concentrations above 1,000 μg/L.

The 2008 Five-Year Review reiterated the recommendation previously identified by the Remediation Systems Evaluation Team, that the IRA be placed in standby mode following the development of decision criteria, which specify the conditions under which the system would be restarted. In 2010, DOE initiated

development of draft criteria for standby assessment in accordance with a recommendation in the 2008 Five-Year Review (DOE 2009a).

In 2011, the FFA managers identified optimization of the Northeast Plume Containment System (NEPCS) as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of off-site groundwater migration followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing and will be documented in the CERCLA Explanation of Significant Difference.

6.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

O&M activities for the NEPCS are conducted in accordance with the *Operations and Maintenance Plan for the Northeast Plume Groundwater Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2002b). The O&M Plan provides an overview of the activities required to operate and maintain the treatment system to meet DOE, EPA, and Commonwealth of Kentucky policies and statutes. Since operation began, the NEPCS has processed approximately 1,303,955,106 gal of water as of December 31, 2012. The treatment system has removed approximately 3,320 lb (274 gal) of TCE.

The costs associated with the O&M of the NEPCS and the NWPGS (which was addressed in Chapter 5) are tracked jointly and have been since FY 2002. The combined cost for both systems for the five-year reporting period is $3.42M, or an average of $6.84K per year. The total operation cost for both the NEPCS and the NWPGS was $28.6M at the end of December 2012.

A site inspection of the NEPCS facilities was made on January 31, 2013. This facility is located south and west of the intersection of Ogden Landing Road (KY Hwy 358) and Little Bayou Creek, northeast of PGDP. The facility consists of the two original EWs, a pumping station, associated piping, electrical power and control systems, security fencing and gates, and interconnecting gravel access roads.

The main access road into the area is secured by a chain-link gate located just south of its intersection with Ogden Landing Road. Operators indicated that the gate is locked at all times except when O&M personnel are in the area. The gate is in good condition and serves its intended function. All the roads in the area appear to be maintained well and in good condition.

The two EWs are located approximately 200 ft apart. Each well is located in an underground concrete vault with a hinged aluminum lid. Each well also is surrounded by a chain-link security fence with an access gate that is locked to prevent unauthorized entry. The vaults are in good condition and are free of foreign debris. The security fences around each well also are in good condition. The immediate area around each fenced location was mowed and appears to be maintained well. During this inspection, both wells were pumping with no apparent problems.

The pumping station, which consists of a large underground EQ tank, a discharge pump and associated piping, and electrical power and control panels, also is completely enclosed in a chain-link security fence with an access gate at one end. All aboveground piping is insulated to prevent freezing. All of the exposed piping and insulation is in good condition and functional. During this inspection, the pumps were running and no operating problems were observed. The electrical power and control panels are in good condition and properly labeled.

The operating engineer was interviewed regarding system operations and system performance. The VOCs are stripped from the water in the C-637 cooling towers. Groundwater and plant process cooling water are

collected in the basins of the cooling towers and recirculated through the cooling tower. After recirculation, water eventually is discharged to the C-616 Lagoons and then through the permitted Outfall 001.

Only minor repairs and routine maintenance have been performed. Shutdowns for repairs have been infrequent; no shutdowns have been long-term during the period of this Five-Year Review. A summary of both routine and nonroutine maintenance is reported in the DOE PGDP FFA Semiannual Progress Report. In accordance with the substantive requirements of the ARARs cited in the ROD, a tank tightness test and leak tests were successfully conducted in 2007 on the Northeast Plume EQ tank and high density polyethylene transfer lines, respectively. No leaks were identified during the tests. Per discussions with the FFA managers in March 2012, the tank tightness and leak tests scheduled for 2012 were rescheduled for May 2013 to allow for testing of newly constructed pipelines. These pipelines were installed as part of a new water treatment unit that will work in conjunction with the existing EQ tank and pipelines; however, the EQ tank and transfer lines are ancillary equipment that is connected to the cooling tower which has been determined to meet the definition of an exempt wastewater treatment unit.

6.4 TECHNICAL ASSESSMENT

The NEPCS is an IRA to control the high concentration area of the Northeast Plume that extends outside the plant security fence and to track contaminant migration to assess the IRA's performance.

The EWs of the Northeast Plume EW Field (EW331 and EW332) began operation on February 28, 1997 (Figure 6.1). Trends of TCE concentrations in groundwater of the Northeast Plume EW field monitoring system clearly show that TCE levels have been reduced by the pump-and-treat system (Table 6.1).

Table 6.1. Summary of TCE Concentration in the Northeast Plume EW Field

	TCE Concentration (µg/L)			Concentration Trends	
Well	Early 1997	Low of 2003	2012	Through 2003	2004–2012
MW283	1,300	120	52–65	Reduction	Near steady reduction
MW291	1,400	100	38–59	Reduction	Near steady reduction
MW294/293A	2,000	280	200–230	Reduction	Near-steady reduction
MW288*	1,600	240	130–210	Reduction	Near steady reduction
MW292*	800	430	200–280	Rise to 1,400 µg/L, then decline to 440 µg/L	Near steady reduction
MW284**	1,500	140	See footnote	Reduction	See footnote, ranged 110–150 µg/L in 2004 and 2005

*MW288 and MW292 are upgradient wells.
**MW284 data for 2012 is not available because the well was last sampled for TCE in August 2005. All results obtained from January 2001, until the last sampling activity were below 250 µg/L with steady reduction shown throughout the sampling period.

1,1-DCE, is presented as the only other COC in the ROD. Since the ROD was signed, laboratory reporting limits for 1,1-DCE have decreased from 25 to 50 µg/L to 5 to 10 µg/L. This change resulted in the first detections of 1,1-DCE in samples from the Northeast Plume EQ tank (12 and 25 µg/L) in 2007; since February 2009, 1,1-DCE concentrations have ranged from 5 to 10 µg/L. The 1,1-DCE present in the plume is being captured by the Northeast Plume EW Field.

As with the previous EW fields of the Northwest Plume IRA, a primary concern of the NEPCS is the extent of the zone of capture of the EW field. To ensure that an adequate zone of capture remains during periods when only one of the two well pumps has been idled by power supply failure to the pump or due to maintenance, the system operators have increased the pumping rate of the working well.

Operational efficiency (actual run time compared to 100% run time) typically exceeds the operational goal of 85%, often averaging better than 95% over a three-month period. For the period 2003 through 2012, TCE concentration levels from the EWs have remained near steady, declining to approximately 100-200 µg/L (Figures 6.2 and 6.3). Tc-99 levels have risen to approximately 30 pCi/L[2] in EW233 because continued operation of the EWs has pulled Tc-99-contaminated groundwater from the area of the plant.

TCE levels in all MWs and EWs associated with the Northeast Plume Groundwater System exhibit declining trends. The data indicate that the EWs are effective at controlling the high-concentration core of the Northeast Plume and that the TCE levels within the upgradient Northeast Plume are declining.

DOE installed 28 MWs near the east PGDP security fence and in downgradient reaches of the Northeast Plume as part of the recent monitoring well upgrade project (October 2009 through February 2010). An was used to characterize the location of the centroids of the Northeast Plume near the east PGDP security fence to optimize the location of these wells. Results from these MWs were incorporated into the latest update of maps of the PGDP plumes (for calendar year 2010) (see Figure 6.1).

The IRA is intended to control the north end of the high concentration core of the Northeast Plume (1,000 µg/L and greater TCE). Monitoring data from throughout the plume document that the Northeast Plume TCE concentrations have diminished and are significantly less than 1,000 µg/L. Consistent with the sitewide strategy, which includes control of the migration of groundwater contamination from the site, DOE continues to operate the NEPCS. The TCE concentrations in the treatment system effluent continue to meet the target levels. TCE concentrations are less than 5 ppb, as indicated in the latest FFA semiannual reporting period of January–June 2012 (see Table 6.2).

Table 6.2. Northeast Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)		
	High	**Low**	**Average[a]**
Influent	170	120	153
Effluent	< 1	< 1	< 1

Data is taken from the DOE PGDP FFA Second Semiannual Progress Report for Fiscal Year 2012, Paducah, Kentucky (DOE 2012a).

[a] Average is calculated as an arithmetic average.

[2] The current limit of 900 picocuries per liter (pCi/L) Tc-99, as calculated by EPA, is based on the MCL for man-made beta and photon emitters in drinking water to a target annual dose to the total body or organ of 4 mrem/yr. This calculation was based on biokinetic models and data from National Bureau of Standards Handbook 69, published in 1963. Since that time, additional dosimetric research has been performed with more advanced biokinetic models. In 2011, DOE published the "DOE Standard: Derived Concentration Technical Standard (DOE-STD-1196-2011" which provides concentration standards for public consumption of drinking water that equate to an effective dose of 100 mrem/yr. The 2011 standards are based on current biokinetic and dosimetric methodologies which utilize both gender and age specific physiological parameters for Reference Man found in International Committee on Radiation Protection Publication 72 (ICRP 1996) and Publication 89 (ICRP 2002). In addition, the most current information on energies and intensities of radiation emitted by the various radionuclides found in ICRP Publication 107 (ICRP 2008) were also used in the derivation of the DOE concentration standards. The published derived concentration standard (DCS) for Tc-99 in drinking water is 4.4E-5 microcuries per milliliter (µCi/ml) or 44,000 pCi/L. As this value indicates, the concentration that will yield an effective dose of 100 mrem/yr from the ingestion of drinking water, the value to yield an effective dose of 4 mrem/yr is calculated by multiplying the DCS by 4% or 0.04. This calculation yields a value of 1,760 pCi/L. While the historically calculated value of 900 pCi/L continues to be utilized by EPA as the concentration based MCL for Tc-99, when calculated using current methods, a larger value is yielded. When 900 pCi/L is evaluated using the methods outlined in the DOE standard, it equates to an effective dose of 2 mrem/yr or ½ of the EPA MCL for public consumption of drinking water.

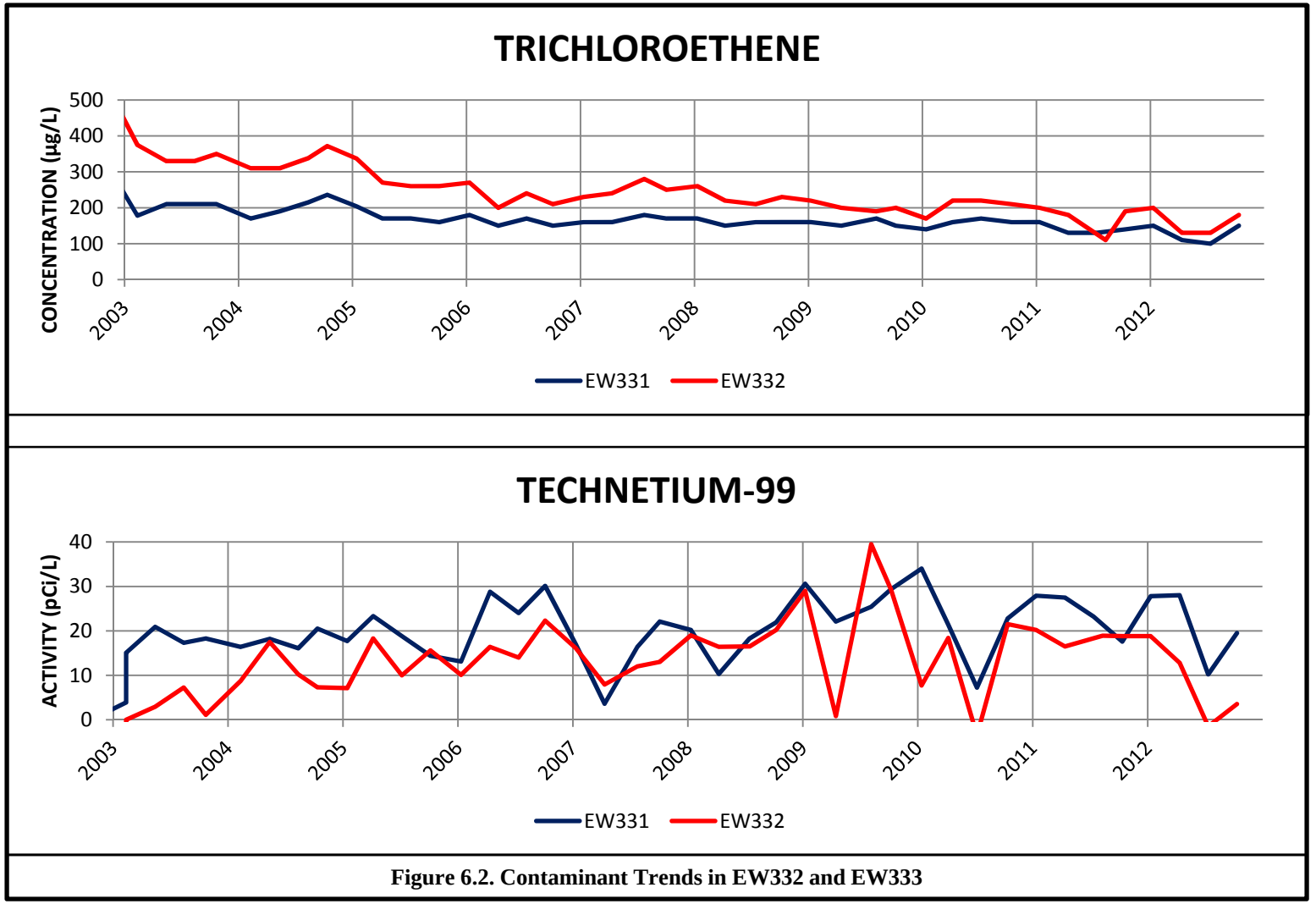

Figure 6.2. Contaminant Trends in EW332 and EW333

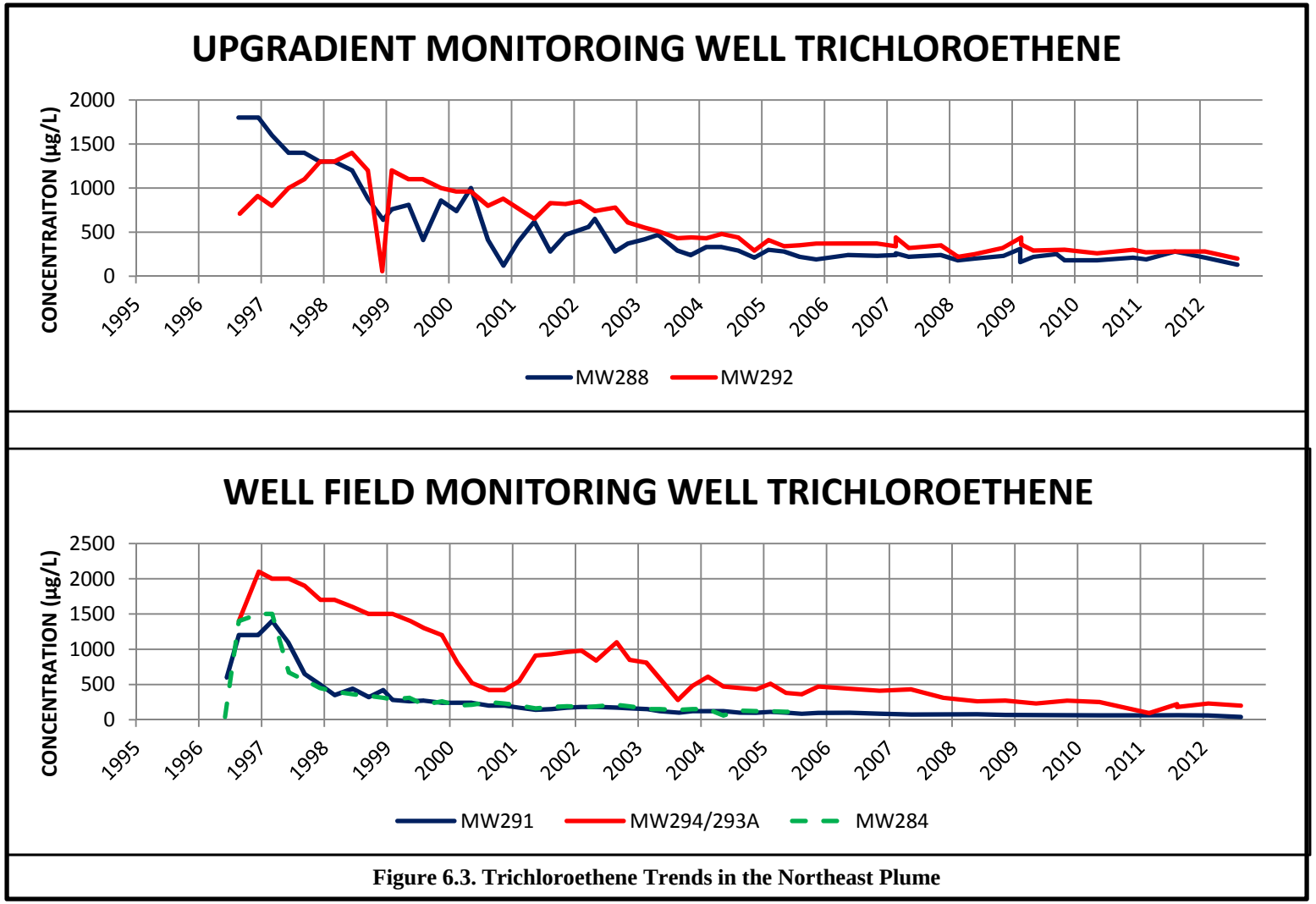

Figure 6.3. Trichloroethene Trends in the Northeast Plume

6.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. This review of data and the site inspection indicate that the remedy is functioning as described in the ROD and objectives have been met. DOE continues to operate the NEPCS to control off-site migration of contaminated groundwater, consistent with the sitewide strategy. There have been no changes in the physical conditions of the site that would affect the value of the remedy. The action inherently benefits downgradient areas by limiting the advance of the plume. Reviews of groundwater monitoring data and the results of the site inspection all indicate that the Northeast Plume Groundwater System is functioning as designed.

6.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

PGDP's Northeast Plume underlies land controlled by DOE and sparsely populated areas northeast of the PGDP and borders on residences (to the east) located along Metropolis Lake Road. DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater in the area of the plume through a license agreement process with landowners and by providing household water supply to the area residents. Exposure assumptions used in the ROD regarding future domestic use of groundwater off DOE property remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

The exposure assumptions used to develop the PHEA included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker). The MCL for TCE remains 0.005 mg/L as it was during the original remedy selection; however, the original remedy was based on the assumption that there is no exposure pathway because the water policy (as discussed in Chapter 8) prevents access to the contaminated groundwater. The changes to the parameters for risk evaluation of TCE, therefore, have no effect on the protectiveness of the remedy because the exposure assumption (no exposure) is still valid.

The single goal identified for the Northeast Plume ROD, to initiate hydraulic control of the high concentration area that extends outside the plant security fence, remains valid.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. The ROD identified a chemical-specific ARAR for discharge of TCE to the creek of 81 μg/L as controlled by the KPDES Permit; however, the water quality criterion was lowered to 30 μg/L. The discharges from the Northeast Plume treatment never have exceeded this lower value; therefore, this change in standards has no impact on the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy.

6.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

6.4.4 Technical Assessment Summary

The operational data and the site inspection indicate that the mechanical components of the remedy are functioning as intended by the ROD.

The Northeast Plume IRA consists of groundwater extraction from two EWs located near Ogden Landing Road at Little Bayou Creek. This EW field is intended to control migration of the high-concentration core of TCE contamination off the DOE property. Contaminant levels in the area of the EW field have significantly decreased since the initiation of the Northeast Plume IRA and are continuing to decline. The thick interval of relatively low-permeability silt that overlies the Northeast Plume should reduce the potential for transport of VOC vapors from the Northwest Plume to the surface. While operation of the NEPCS is an interim action, it is effectively protective in conjunction with other PGDP programs (notably the Water Policy).

Moreover, DOE is performing an optimization of the NEPCS in response to the recommendation of the 2008 Five-Year Review. DOE has performed groundwater modeling to optimize the configuration of groundwater extraction near the eastern fenceline for the Northeast Plume and is currently in the process of designing two new EWs (with air stripper treatment systems) to be placed near the east PGDP security fence. The new EWs to be constructed near the east PGDP security fence are expected to provide an interim, optimized approach to capture dissolved contamination derived from the sources of the Northeast Plume.

6.5 ISSUES

None.

7. CYLINDER DROP TEST AREA OR LASAGNA™ TECHNOLOGY DEMONSTRATION

The Cylinder Drop Test Area (SWMU 91) encompasses approximately 1.7 acres and is located in the extreme west-central area of PGDP on the southern edge of the C-745-B Cylinder Yard. Figure 7.1 illustrates the location of Cylinder Drop Test Area. Drop tests were conducted from late 1964 until early 1965 and in February 1979. These tests were used to demonstrate the structural integrity of the steel cylinders that were used to store and transport uranium hexafluoride (UF_6). Prior to the drop test, the cylinders were cooled by immersing them in a solution of dry ice and TCE that was in an open pit. After the cylinders were chilled, a crane lifted then dropped them onto a concrete and steel pad to simulate worst-case transportation accidents. The TCE was not removed from the pit after the tests and eventually vaporized or leaked into the surrounding shallow soil and groundwater. The likely maximum quantity lost to the surrounding soil is approximately 1,635 L (430 gal). Additional information regarding the nature and extent of contamination is presented in the *Results of the Site Investigation, Phase II* (CH2M HILL 1992), and the *Preliminary Site Characterization/Baseline Risk Assessment/Lasagna™ Technology Demonstration at Solid Waste Management Unit 91 of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (LMES 1996a).

Results of the initial investigations conducted at SWMU 91 indicated that organic contaminants were present in both soil and groundwater at the unit. The maximum concentration of TCE in subsurface soil was 1,523 mg/kg, and in shallow groundwater it was 943 mg/L. The area of TCE contamination was approximately 6,000 ft^2, and the average TCE concentration was 84 mg/kg. The sampling results indicated that TCE had migrated below the water table into the UCRS, but had not fully penetrated the aquitard above the RGA at the unit. Contamination was present in the subsurface soils to an approximate depth of 45 ft bgs.

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the Cylinder Drop Test Area is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled (DOE 2009a).

7.1 REMEDY SELECTION

In 1993, the Cylinder Drop Test area was selected as the site of an innovative technology demonstration. The technology, known as Lasagna™, uses electro-osmosis to move shallow groundwater and contaminants in fine-grained or clayey soils. Contaminants are treated by passing contaminated groundwater through in-ground treatment cells. The success of the initial 120-day demonstration (Phase I), which began in January 1995, led to a full-scale demonstration (Phase IIA) that was conducted from August 1996 through July 1997. Sampling and analytical results from the Phase I study are reported in the *Preliminary Site Characterization/Baseline Risk Assessment/Lasagna™ Technology Demonstration at Solid Waste Management Unit 91 of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (LMES 1996a). During the second phase of the technology demonstration, the average TCE concentration in the demonstration area soil was reduced by 95%. Post-test soil sampling conducted for the Phase IIA demonstration indicated that cleanup effectiveness of Lasagna™ would achieve the cleanup goals. The results of the Phase IIA are discussed further in the *Lasagna™ Soil Remediation: Innovative Technology Summary Report* (LMES 1996b).

DOE then selected Lasagna™ for full-scale remediation of the Cylinder Drop Test area and documented this decision in the *Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1527&D2

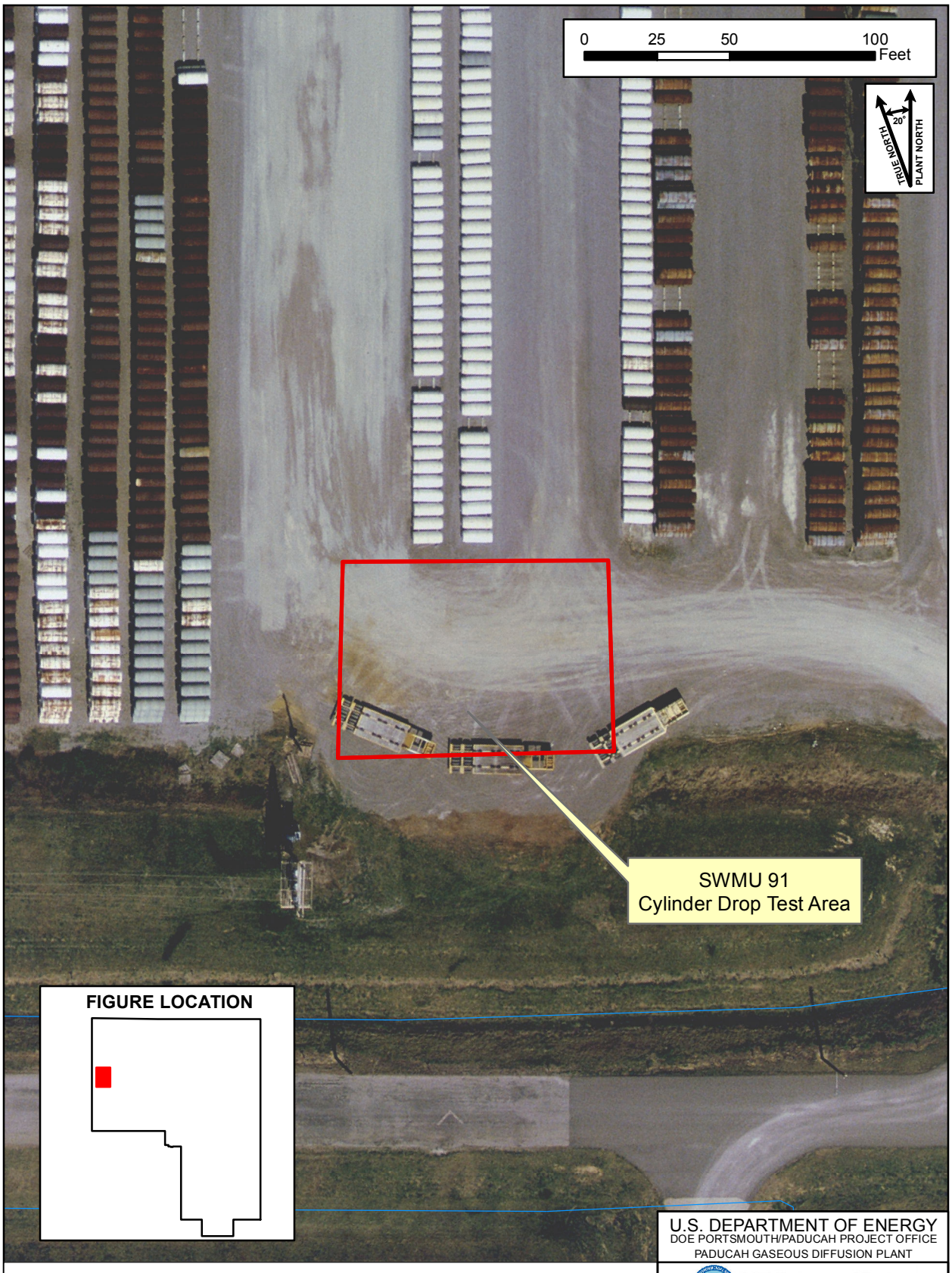

Figure 7.1. Location of Cylinder Drop Test Area

(DOE 1998a) with EPA approval and KDEP concurrence, September 1998. The ROD identified the selected remedy, outlined the performance objectives, and provided rationale for the remedy selection. The remedy consisted of treatment of contaminated soil pore water by the Lasagna™ electro-osmosis technology. The RAO was to mitigate migration of TCE beyond the SWMU boundary through the groundwater by the soil leaching pathway. Reduction of the concentration of TCE in soil to at least 5.6 mg/kg, reduced the potential for future releases to groundwater that could pose a threat to human health and the environment at the nearest point of exposure in groundwater. The following are the specific components of the selected remedy.

- Treatment zones containing reagents that either decompose the TCE to nontoxic products or adsorb the TCE and make it immobile (DOE 1998a).

- Electrodes (a cathode and an anode) that, when energized, moved contaminants (i.e., TCE) into or through the treatment zones and heat the soil. The contaminated water in the soil pores flowed from the anode through treatment zones toward the cathode (DOE 1998a).

- A water management system that recycles and returns the water that accumulates at the cathode back to the anode for acid-base neutralization (DOE 1998a).

The ROD specified that the Lasagna™ system operate for two years, but, if necessary to meet the clean-up objectives, the operation may be continued until cleanup levels are reached. The ROD also included a contingency action to use soil mixing to enhance the remedial technology in the event that the Lasagna™ technology by itself was incapable of achieving cleanup objectives. Additional information regarding the selected remedy is presented in the ROD for SWMU 91 (DOE 1998a).

7.2 REMEDY IMPLEMENTATION

All phases of the Lasagna™ technology demonstration have been completed. In March 1999, a contract was awarded for installation and operation of the full-scale remediation (Phase IIb) using the Lasagna™ technology. The Remedial Design Report (RDR) to support the construction was issued in May 1999 and construction began in August 1999. The construction was completed and operations began in December 1999. The *Post-Construction Report for the Lasagna™ Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000b) documents the remedial construction process. The construction phase also included collection of soil samples to establish a baseline of contamination in the system area prior to remediation.

The remedial system operated from December 1999 through December 2001. The results of post-cleanup verification sampling indicated the average concentration of TCE was 0.38 mg/kg, with a maximum concentration of 4 mg/kg. The Lasagna™ remedial action reduced the TCE soil concentrations well below the RAO of 5.6 mg/kg average concentration.

The system operated continuously for the first several months. After the soil temperature reached 90°C, the system was put into pulse mode to prevent overheating of the soil. Pulse-mode operations consisted of energizing the system for one to four days and then shutting it down for several days to allow the soil to cool. Soil samples were collected in August of 2000 and in August of 2001. Due to mechanical problems, the system was shut down for approximately eight weeks beginning in August 2001. A number of additional operational problems were encountered during the operational phase and are detailed in the *Final Remedial Action Report for Lasagna™ Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2002c). The Commonwealth of Kentucky and EPA approved the final remedial action report on October 31, 2002.

A site inspection was conducted on February 4, 2013. The site includes a grassy area south of the C-745-B cylinder yard and part of the area underlying a portion of the gravel cylinder yard. No construction or operations activities were being conducted at the time of the site inspection.

Lasagna™ verification sampling and analysis were conducted in April 2003 and confirmed that the remediation objective was met. Details of the Lasagna™ verification sampling and analysis are included in the *Addendum to the Final Remedial Action Report for Lasagna™ Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003a).

The Lasagna™ equipment and site was demobilized on September 30, 2002. The remediation site has been returned to its original condition. The total cost of the implementation of the Lasagna™ remediation (i.e., post-ROD activities) was $3.96M (DOE 2002c).

7.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

There is no O&M for this remedy.

7.4 TECHNICAL ASSESSMENT

The remedy was designed to be protective of future groundwater use at the fence line of PGDP by meeting the TCE MCL value of 5 µg/L. The MCL for TCE remains at 5 µg/L, and the average residual soil level of TCE at the SWMU is less than one-tenth of the original level calculated to be protective of groundwater in the ROD; therefore, the remedy employed is as protective as it was when the ROD was implemented.

The residual concentrations of TCE in soil (post-remediation) are an average 0.38 mg/kg and a maximum of 4 mg/kg.

7.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed by being protective of future groundwater use at the fence line by the reduction of TCE concentrations in soil.

In 2011, EPA revised the cancer slope factors and toxicity data for TCE. The 2011 PGDP no-further-action level was based on a more conservative KDEP cancer slop factor and had an industrial screening value of 0.0619 mg/kg for the excavation worker at 1×10^{-6} (DOE 2011b). Using these screening levels, the mean concentration corresponds to 6×10^{-6} risk using the PGDP/KDEP value. The maximum value at the SWMU corresponds to 6.5×10^{-5} risk using this same value. Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for future use of the SWMU based on the measured concentrations of TCE in soil after the remediation was completed.

7.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. DOE remains in control of the property that SWMU 91 encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD remain valid. There have been changes to

the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants or new understanding of geologic conditions identified.

Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for the excavation worker, and future groundwater use at the fenceline of the facility based on the measured concentrations of TCE in soil after the remediation was completed. The cleanup levels established in the ROD were met and still are valid.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAO used at the time of remedy selection still is valid.

7.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

7.5 ISSUES

None.

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8. WATER POLICY

Upon detecting TCE and Tc-99 in private wells located north of PGDP in August 1988, DOE immediately placed affected residences/businesses on alternate water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. DOE developed the PGDP Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (EE/CA) (DOE 1993b), and the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1994b).

The actions associated with the remedy selections of the Northwest and Northeast Plumes mitigate the continued migration of the higher concentration portion of the plumes. The Water Policy response action mitigates risk that could be posed through use of the contaminated groundwater by residents. The 2008 Five-Year Review did not identify any issues or recommendations. No significant changes have occurred during the previous five-year period.

The 2008 review stated the following protectiveness statement.

> The remedy for the Water Policy Box currently protects human health and the environment by institutional controls; however, additional actions under the dissolved-phase plume need to be evaluated for long-term protection.

8.1 REMEDY SELECTION

The PGDP Water Policy states, "It is the intent of the PGDP Environmental Restoration Program to offer municipal water service in accordance with this Policy to all existing private residences and businesses within the projected migration area of the contaminated groundwater originating at Paducah Gaseous Diffusion Plant (affected area)." With the adoption of the Water Policy, DOE focused its groundwater monitoring program on the Water Policy Box and adjacent areas that might be affected if and when the plume migrates or expands. Figure 8.1 is a map of the groundwater contaminant plume boundaries and the Water Policy boundary as of 2007.

In June 1994, DOE signed the Action Memorandum for the Water Policy, which included the following conditions:

- DOE offered to provide municipal water to all existing residences and businesses within the affected area surrounding PGDP. They also offered to pay for installation of water supply mains and connection of those residences that were not connected to a public water supply at that time. These residences and businesses were responsible for cooperating and working with the West McCracken Water District to connect the water supply.

- DOE offered to pay the reasonable costs of water bills in the affected area through December 1997, at which time the Water Policy was to be reevaluated and a decision made whether to continue, modify, or eliminate it. The definition of "reasonable cost of water consumption" for residents was based on the historical usage of each owners' well. Water usage increases caused by increases in agricultural water use, livestock water use, or subdivision of property were not to have been reimbursed.

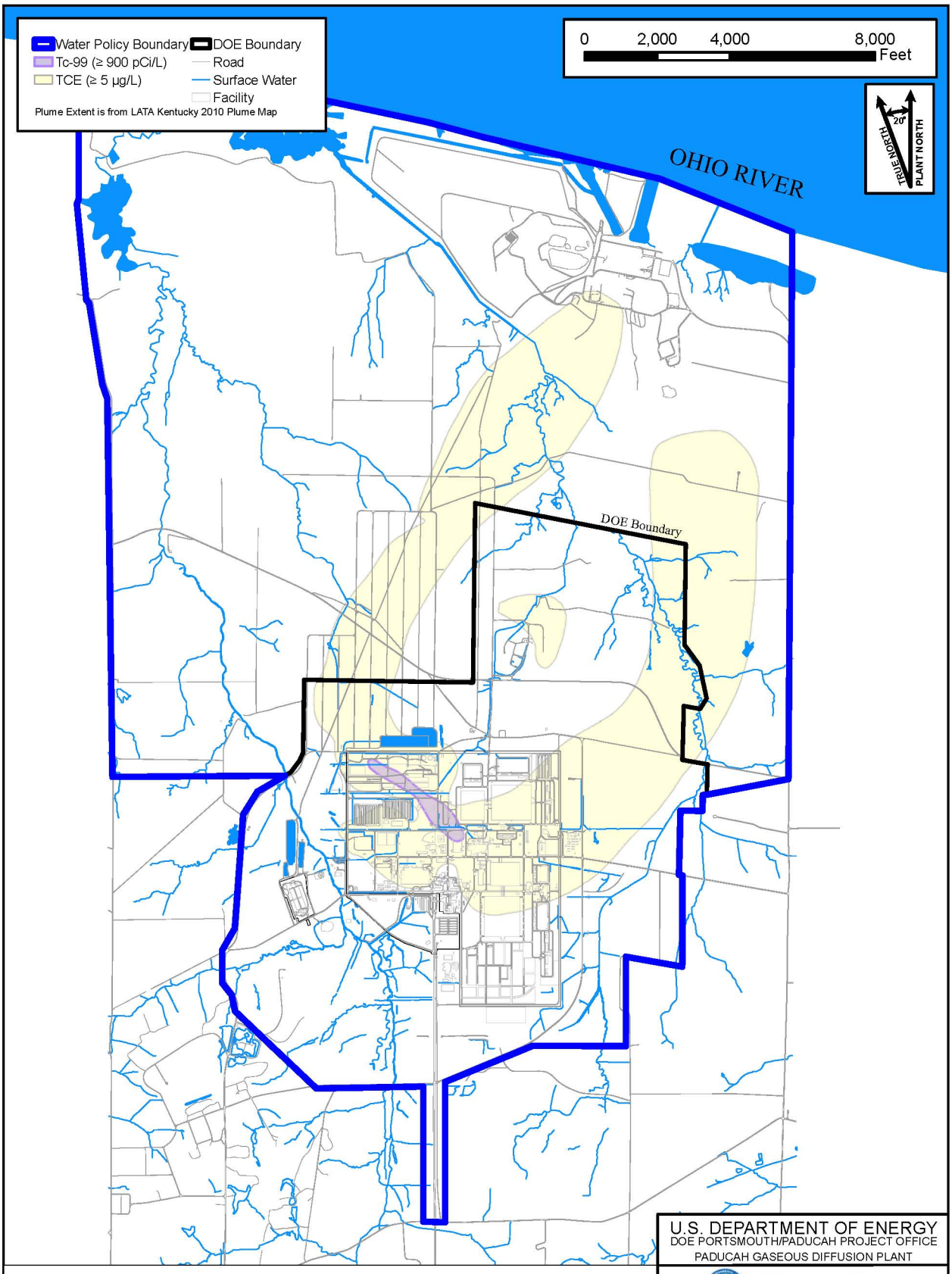

Figure 8.1. Location of Water Policy Boundary in 2013

- Each household or business in the Water Policy Box was asked to sign an agreement with DOE that delineated the responsibilities of each property owner and DOE. The agreements specify that the property owner will not drill new water supply wells or use existing water wells, and that PGDP personnel are permitted access to the property for sampling purposes. PGDP personnel installed locks to prevent unauthorized use of the existing water wells.

- DOE samples existing residential water supply wells and MWs to track migration of groundwater contaminant plumes. Additional MWs are installed as required for other environmental restoration programs.

The EE/CA also specified the need to conduct a Five-Year Review (DOE 1993b).

8.2 REMEDY IMPLEMENTATION

DOE has obtained Water Policy agreements with 60% of residents located within the Water Policy Boundary. West McCracken Water District records indicate that all residents have chosen to use municipal water; however, some landowners have chosen not to sign the license agreements.

As noted in the 2008 Five-Year Review, DOE continues to reevaluate the Water Policy removal action implementation with respect to the license agreement usage and payment of current water bills.

8.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

DOE paid for water supply line extensions of the West McCracken Water District into the Water Policy Box. Total capital construction cost for implementation of the Water Policy was $1,027,781. The average annual cost to implement the water policy program is $170K. This includes an average of $60K for annual water bill payments, $90K for annual management of the program, and $20K for land access and/or monitoring rights for sampling wells on private property. This sampling is either for monitoring groundwater inside the Water Policy Box via DOE-owned and -installed groundwater MWs, or sampling of privately owned residential wells that are located outside the Water Policy Box.

DOE regularly collects groundwater samples from the area in the Water Policy Box and recently has expanded the residential well monitoring from 2008. Beginning in December of 2012, 11 residential wells are sampled annually and 8 residential wells, along with 14 other monitoring wells, are sampled quarterly (LATA Kentucky 2012b). The interval of sampling of each well within the water box has been adjusted to characterize temporal variations within the plumes and to confirm migration paths near the northwestern and northeastern boundaries. DOE reports the results of groundwater monitoring in its Annual Site Environmental Report.

8.4 TECHNICAL ASSESSMENT

The primary objective of the removal action is to prevent local residents from using contaminated groundwater by providing municipal water to residences and businesses and eliminating the use of private water wells.

DOE pays the water bills for the majority of users. The extent of the groundwater contaminant plumes continue to be monitored. DOE has secured legal agreements, known as license agreements, with 55 of 91 landowners within the area affected by the Water Policy. Thirty four landowners have not signed license

agreements; however, DOE still pays their municipal water bills. Two landowners have requested and agreed with DOE to pay their own water bill. The two land owners who have requested this, were informed of the risk associated with consuming the groundwater. An inspection program checks numerous residential wells to ensure that they remain nonoperational.

The monitoring of groundwater in and around the Water Policy Box confirms that the groundwater plumes have not migrated beyond the current water policy boundaries and indicates that the current Water Policy Box still is protective.

8.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The Water Policy removal action is meeting the objectives specified in the Action Memorandum by providing municipal water to the residents of the affected area (the Water Policy Box). The action continues to eliminate the exposure pathway to the groundwater, which is supported by monthly water usage data provided by the West McCracken County Water District, indicating that residents are utilizing the municipal water.

It is recommended that DOE optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater and that land ownership be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box.

8.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. The exposure assumptions used in the AM remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants identified.

The current groundwater data indicate that assumptions underlying the remedy selection still are valid.

No cleanup levels were established in the AM because the scope of the removal action was to supply potable water to residences and businesses within the area surrounding the PGDP that could be affected by migration of groundwater contamination originating from the plant. The purpose of this action is to reduce any potential public health hazard that might result from exposure to groundwater contaminants.

There are no changes in standards identified as ARARs in the AM that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the AM that impact the protectiveness of the remedy.

The RAO used at the time of remedy selection still is valid.

8.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

The remedy remains protective by providing municipal water to the majority of the residents of the affected area (the Water Policy Box). Monitoring data demonstrate that the plume has not migrated beyond the boundaries of the Water Policy Box.

8.4.4 Technical Assessment Summary

The Water Policy Box eliminates potential pathways of exposure to the public by providing municipal water to affected residents and businesses within the Water Policy Box. The Water Policy remains effective for the purpose for which it was intended.

8.5 ISSUES

All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all landowners have signed license agreements for their properties; therefore, potential risk exists that residents would use their groundwater.

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9. C-400 ELECTRICAL RESISTANCE HEATING

The C-400 ERH project currently is underway. This project is included in this Five-Year Review with summaries of activities consistent with the progress of the project up to the date of the review; therefore, the entire five-year evaluation is not included.

The C-400 Cleaning Building is located near the center of the industrial section of PGDP. The building is bounded by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively. Figure 9.1 shows the location of the C-400 Cleaning Building and immediate area. Historically, some of the primary activities associated with the C-400 Building have been cleaning of machinery parts, decontaminating the interiors of used uranium UF_6 cylinders, disassembling and testing of cascade components, and laundering of plant clothes. The building also has housed various other processes and activities, including recovery of precious metals and treatment of radiological waste streams.

In June 1986, a routine construction excavation along the 11th Street storm sewer revealed TCE soil contamination. The cause of the contamination was determined to be a leak in a drain line from the C-400 Building's basement sump to the storm sewer. The area of contamination became known as the C-400 TCE Leak Site and was given the designation of SWMU 11. After the initial discovery of contamination, four borings were installed to better define the extent of the soil contamination. SWMU 11 and the C-400 Building area have been the subject of several investigations since then.

Significant occurrences of TCE-contaminated soil and groundwater were detected during the WAG 6 Remedial Investigation (RI). Some results indicated the presence of TCE as a DNAPL. TCE was identified in two hydrostratigraphic units: the UCRS and the RGA. At C-400, the UCRS extends from surface to approximately 56 ft to 66 ft below ground surface (bgs). The RGA extends from the bottom of the UCRS with a thickness range of approximately 25 ft to 36 ft.

While current plant policies limit direct contact risk, the source zone presents potential risk via vapor intrusion into C-400 and the vicinity of PGDP infrastructure. To examine this risk, DOE performed sampling for vinyl chloride, the contaminant determined to pose the greatest risk via the inhalation exposure route, in enclosed spaces at PGDP during the spring of 2000 (DOE 2001a). Locations sampled included the underground cable tunnel from C-337 to C-300, the underground cable tunnel from C-331 to C-531, the underground tunnel from C-333 to the approximate location of the old millwright shop, and the C-400 basement. During this sampling, vinyl chloride was not detected at any location (detection limit of 0.85 ppm).

Two previous actions have remediated some of the soil contamination near the southeast corner of C-400 Building. After the discovery of the C-400 TCE Leak Site in June 1986, some of the soils were excavated in an attempt to reduce the contamination in the area. Approximately 310 ft^3 of TCE-contaminated soil was drummed for off-site disposal. The excavation was backfilled with clean soil, and the area was capped with a layer of clay. A 2003 Six-Phase Heating Treatability Study removed over 22,000 lb of TCE (approximately 1,900 gal) from the subsurface in a 43-ft diameter treatment area (5,378 yd^3 of contaminated soil and subsurface aquifer) in the southeast corner of the area near the C-400 Building.

As part of the Six-Phase Heating Treatability Study in the C-400 source zone, project personnel characterized TCE and vinyl chloride levels in air samples from the C-400 basement and the C-300 tunnel on 18 separate days during April 2003, when soil heating first ramped up to the target temperature in the area UCRS and RGA soils (DOE 2004). None of the VOC tests (via Draeger tube) detected an occurrence of the VOCs (with a detection limit of 2 ppm for TCE and unspecified for vinyl

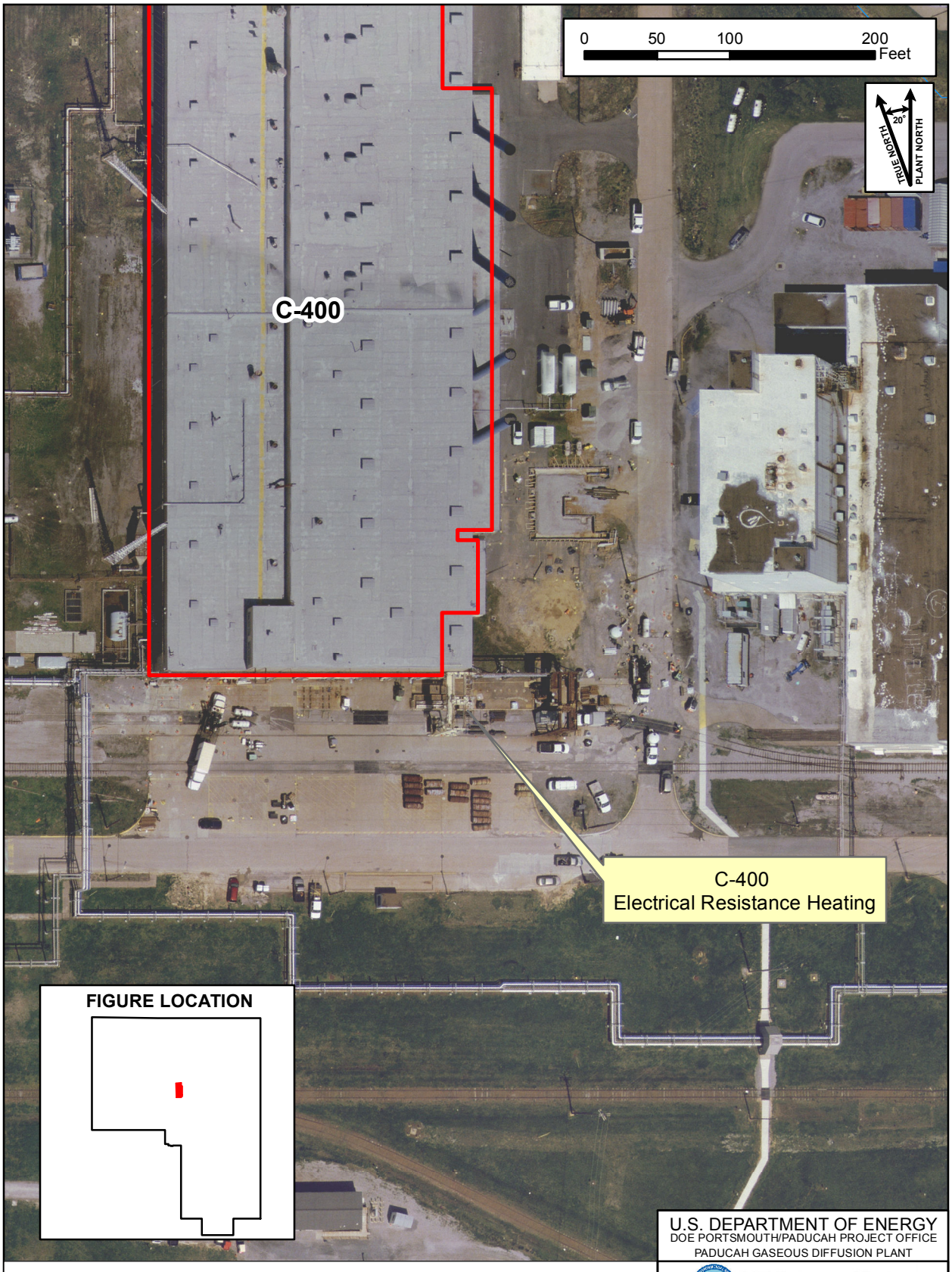

Figure 9.1. Location of C-400 Electrical Resistance Heating

chloride). This testing, along with the vinyl chloride sampling in enclosed spaces at PGDP during the spring of 2000, demonstrate that past conditions have not completed a vapor intrusion pathway of risk associated with the C-400 source zone.

The 2008 review stated the following protectiveness statement.

The remedy at C-400 involving ERH is expected to be protective of human health and the environment upon completion, and, in the interim, exposure pathways that could result in unacceptable risks are being controlled.

9.1 REMEDY SELECTION

Following the RI (DOE 1999a) and the Feasibility Study (FS) (DOE 2001a), a ROD was finalized for an IRA at C-400, *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 (DOE 2005a). The ROD documented the selection of ERH as the technology to address the source area contaminated with TCE and other VOCs.

In 2007, DOE commissioned an independent technical review (ITR) of a draft of the C-400 90% RDR (ITR 2007). The 2007 ITR team consisted of subject matter experts from DOE, the environmental remediation field, and the U.S. Environmental Protection Agency. The ITR Team published their report in October 2007*, Review Report: Building C-400 Thermal Treatment 90% Remedial Design Report and Site Investigation, PGDP, Paducah Kentucky*, WSRC-STI-2007-00427 (ITR 2007). Observations and recommendations from ITR team members helped shape the final design and led to the phased deployment strategy.

The C-400 ERH actions (Phase I and Phase II) include the design, installation, operation, and subsequent decommissioning of ERH systems to heat discrete (vertical and horizontal) intervals of the subsurface source zone resulting in volatilization, removal, and recovery of VOCs from the C-400 treatment area. The remediation goal for this interim action, as documented in the ROD (DOE 2005a), is to operate the 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 the recovery rate is constant (i.e., recovery is asymptotic).

The following are the major components of the selected remedy:

- An RDSI to delineate further the areal and vertical extent of the contamination in the C-400 Cleaning Building area to optimize design of the remedial system;

- Removal and treatment of TCE and other VOCs from the contaminant source zone in the UCRS and RGA at the C-400 Cleaning Building area using ERH;

- Implementation, maintenance, enforcing, and reporting of LUCs on the C-400 Cleaning Building area; and

- Continuation of groundwater monitoring of the free-phase DNAPL and dissolved-phase plumes because some contamination will remain in place following the IRAs.

The ERH technology consists of installing electrodes in the subsurface, energizing them, and heating the subsurface to volatilize contaminants in the groundwater and soil. The volatilized contaminants are captured by aboveground equipment and processed for disposal as hazardous waste.

The RAOs in 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 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

- 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.

9.2 REMEDY IMPLEMENTATION

The 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 2005b), was completed in August 2006. The DNAPL source zone was delineated during the RDSI and, coupled with data from previous investigations, was assessed to delineate the areas of high TCE concentration more accurately, thereby allowing the design team to optimize placement of ERH electrodes, vapor recovery wells, and other subsurface components.

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, was issued in July 2008 (DOE 2008a). The design incorporated two phases to mitigate the risks and uncertainties associated with large scale deployment of ERH in the highly permeable RGA.

Phase I heated and treated subsurface soils in the southwest and east treatment areas (see Figure 9.2). In addition to removing VOCs, another important objective of Phase I was to evaluate the heating performance of the base design in the lower RGA to the McNairy Formation interface in the southwest treatment area. ERH treatment in the east area involved only the UCRS. Phase I operations also provided an opportunity to evaluate the performance of the vapor recovery system, assess hydraulic containment, and optimize the aboveground vapor/liquid treatment system.

Phase I construction began in December 2008 and was substantially complete in December 2009; at that time, start up and shakedown testing began. Testing was completed and operations commenced at the end of March 2010. Heating operations ceased (soil vapor extraction continued) at the end of October 2010, and all system operations ended on December 4, 2010.

DOE installed five MW nests, with screens in the middle and lower RGA, across the northwest corner of C-400 in June 2009 to monitor dissolved contaminant trends near the C-400 source(s) better. In general, the level of dissolved TCE (see Figure 9.3) increases eastward across the well transect on the north side of C-400 (from MW423 to MW424 to MW421) and is greatest at the base of the RGA (port 3/lower screen in each of the well nests). Levels of Tc-99 commonly are greatest in the port 1/top

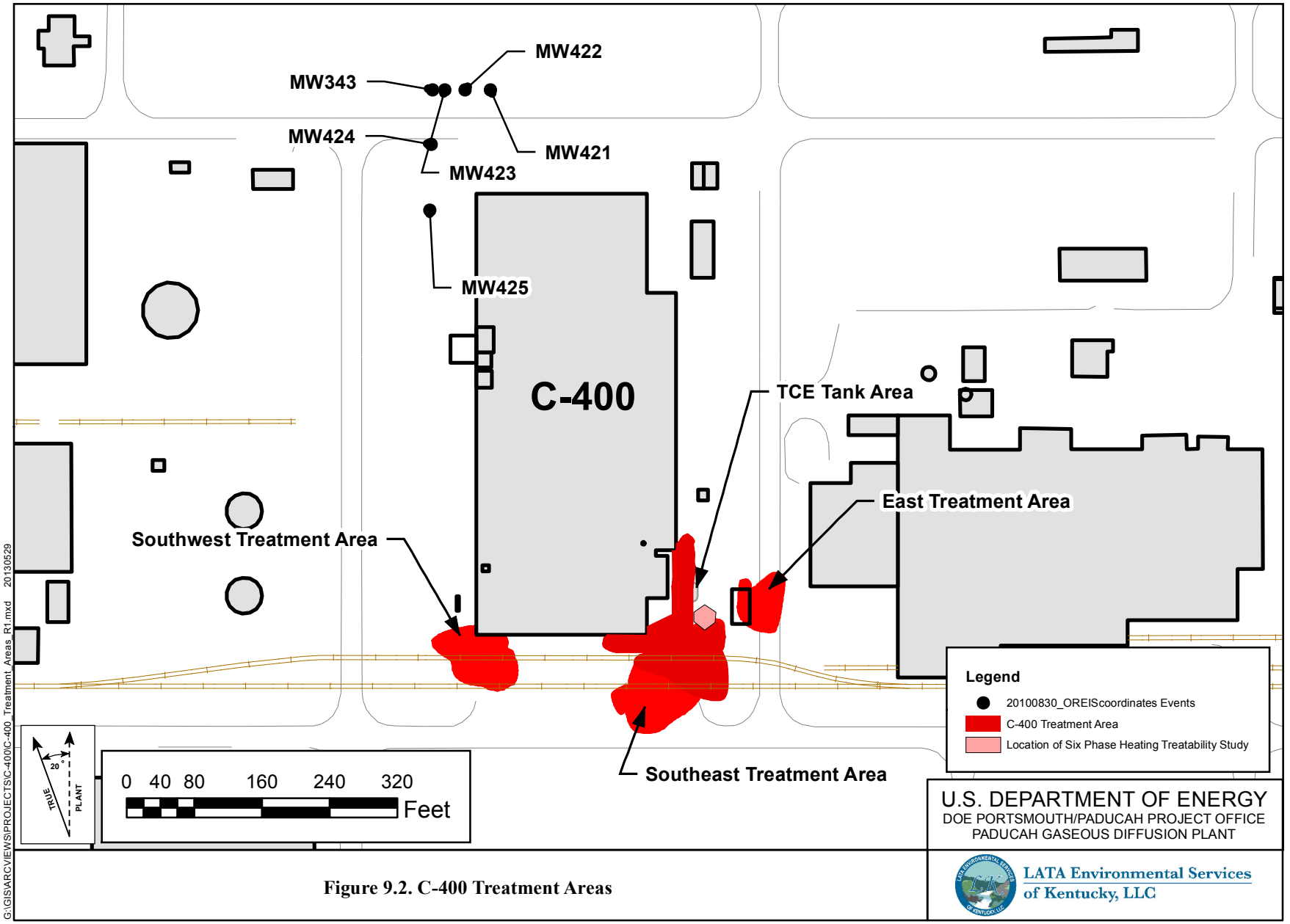

Figure 9.2. C-400 Treatment Areas

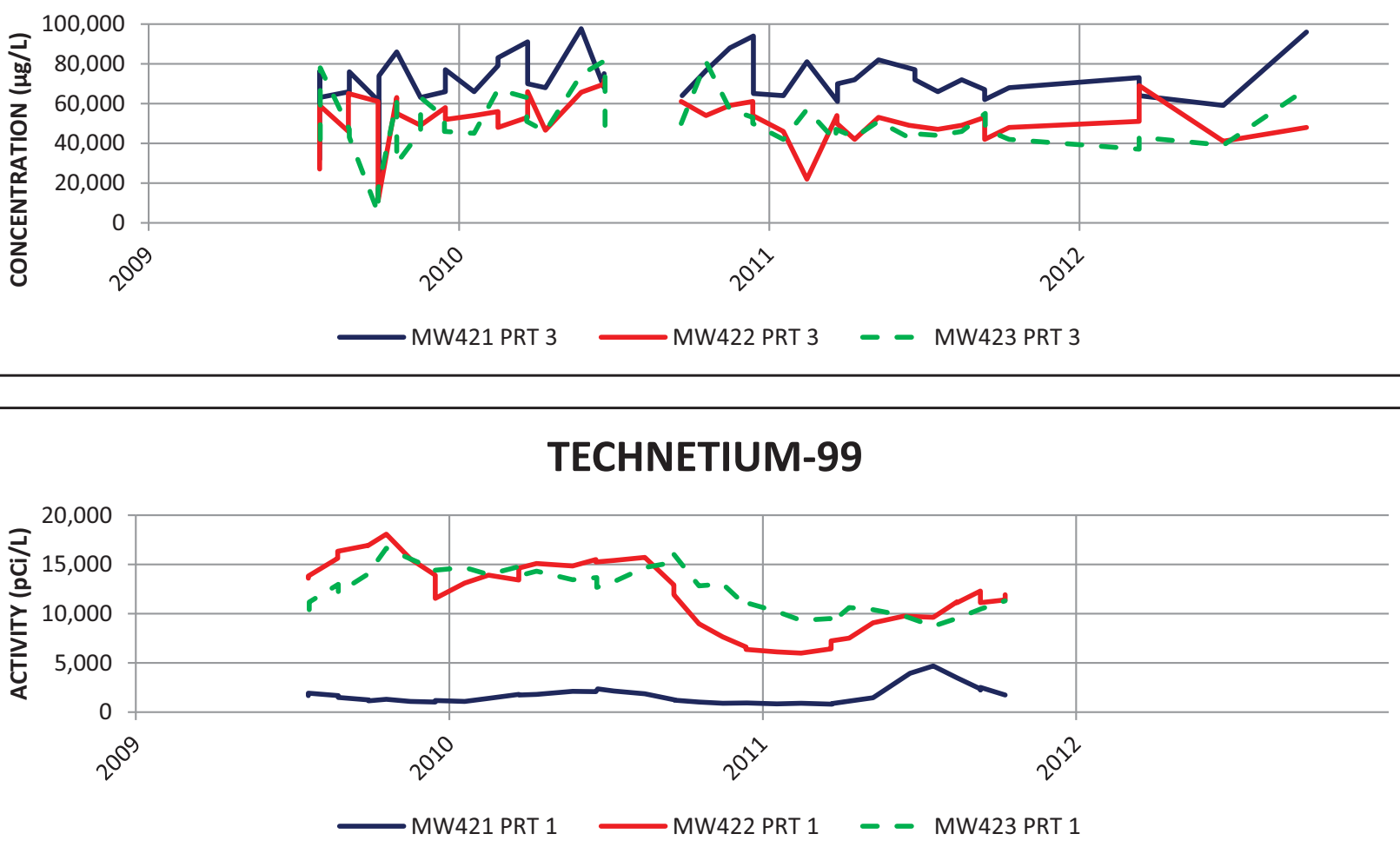

Figure 9.3. Contaminant Trends in MWs Located on the North Side of C-400

screen of the well nests. Through 2012, the C-400 remedial actions have not resulted in any significant decline of contaminant levels in the Northwest Plume at the north side of C-400. A second ITR team, chartered by DOE in September 2010, *Independent Technical Review of the C-400 Interim Remedial Project Phase I Results, Paducah, Kentucky*, SRNL-STI-2010-00681, evaluated Phase I performance and results of preliminary Phase II thermal design modeling (ITR 2010). Observations by the 2010 ITR were included in *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 2011b), issued in August 2011. This report provides descriptions and details of the construction and implementation of the Phase I remedial action, as well as the results of operational and monitoring data collected during and subsequent to Phase I implementation. These data form the basis for evaluation of Phase I performance.

DOE began construction of an ERH system for the Phase II UCRS target zone (Phase IIa) in September 2012, with completion of underground components (electrodes, vapor extraction wells, etc.) scheduled in April 2013. The second ITR team determined that ERH did not reach target temperatures in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was recommended that ERH not be used for the lower RGA as part of Phase II. DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

9.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

For Phase I, drilling and subsurface completion of ERH components (electrodes, multiphase extraction wells, temperature monitoring strings, vacuum piezometers, and water-level monitoring instruments) was completed in June 2009. System testing concluded in March 2010 and normal operations began. Normal operations continued through September 2010 when TCE concentrations in recovered vapor had dropped to asymptotic levels. Pulsed operations then were initiated as detailed in the Paducah C-400 Project pulsed operations plan. The strategy for the pulsing operations was intended to maximize removal of the remaining contaminants from the treatment area by maximizing extraction from the wells and by varying the pressure levels within the subsurface. To maximize the extraction from individual wells, a pattern was initiated that consisted of operating half of the wells while the remaining half was shut down. To vary subsurface pressures, the extraction rates were reduced or increased concurrently with varying the power levels to the electrodes. The process was then repeated for two cycles. Pulsed operations ended in October 2010 and power to the electrodes was turned off at the end of October 2010. Vapor extraction continued for approximately five weeks to facilitate subsurface cooling.

O&M activities for Phase I were conducted in accordance with the *Operations and Maintenance 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/07-0187&D2 (DOE 2009b). Phase I treatment system removed approximately 6,548 lb (535 gal) of TCE. The cost of Phase I was approximately $32.5M.

Phase I heating began on March 27, 2010 and continued over a 164-day period prior to the commencement of pulsed operations on September 7, 2010. During that time, operation of the electrodes was interrupted (power failures and other system problems) for approximately 48 days (29% of the time). Temperature plots in the treatment areas document that the two most significant downtime events in May 2010 and July 2010 had an impact on heating and extended the time needed to reach target temperatures.

9.4 PRELIMINARY TECHNICAL ASSESSMENT

In August 2011, DOE transmitted a *Technical Performance Evaluation for the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, to EPA and KDEP, which provided the results of the Phase I implementation and identified lessons learned and recommendations for Phase II design and implementation (DOE 2011b).

Phase I ERH removed approximately 6,830 lb of TCE (560 gal), which was a small fraction of the original estimate of TCE in the combined east and southwest treatment areas (285,781 lb/23,350 gal). The original estimate of TCE for the southwest treatment area was based on a faulty conceptual model and grossly overestimated the amount of TCE that was present. Collocated baseline (collected before heating) and postoperation (collected after heating) soil samples document 95% and greater reduction in TCE contamination in the treatment zones.

Soil samples obtained from borings used to install ERH equipment were used to determine the concentrations of TCE and TCE degradation products in the soil prior to the operation of the ERH electrodes. Postoperational samples from collocated borings were obtained for comparison to baseline soil sample analyses to determine the residual TCE concentrations subsequent to the operation of Phase I. The paired baseline and postoperational sample results were compared to assess the reduction in concentrations.

Baseline and postoperational soil samples were collected from 12 locations in the east area (Table 9.1 and Figure 9.4). For the east treatment area, there are 25 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 95% reduction in concentration, shifting the average concentration of 584 µg/Kg to 29 µg/Kg. These data demonstrate significant mass reduction within the UCRS in the East Area. Postoperational soil sampling results indicate that the RAOs were achieved in the east treatment area in accordance with the second RAO.

Baseline and postoperational soil samples were collected from 15 locations in the southwest area (Table 9.2 and Figure 9.5). For the southwest treatment area, there are 63 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 99% reduction in concentration, shifting the average concentration of 1046 µg/kg to 15 µg/kg. These data demonstrate significant mass reduction in the southwest area. Postoperational soil sampling results indicate that the RAOs were achieved in the treatment areas (UCRS) in the southwest locations in accordance with the second RAO. The data from 60 to 80 ft intervals demonstrate a reduction in concentrations in the upper RGA in accordance with the third RAO.

Target temperatures were attained in treatment areas and depths targeted for VOC removal, indicating that the ERH design was adequate for thermal treatment of UCRS soils; however, target temperatures were not attained in the deep RGA. Key factors that affected attainment of target temperature in the deep RGA include groundwater flow velocity, formation resistivity, and heat loss due to convective flow.

Observed maximum formation temperatures attained during Phase I operations in the lower RGA fell short of target temperature by over 100ºF. Contingency thermal engineering techniques identified in the RAWP to boost formation heating were implemented during Phase I in attempts to attain target temperatures. These techniques included injection of saline solutions and maximizing the delivery of electrical power to the electrodes in the lower RGA. Phase I operating experience in the southwest treatment area and subsequent modeling results using a groundwater velocity of 3.0 ft per day indicate that, in order to achieve target temperatures in the RGA, the ERH configuration developed for Phase I would require significant scale up (e.g., additional electrodes, with hot water injection within the target zone, upgradient electrodes for preheating, and upgradient groundwater extraction to reduce the flux of

Table 9.1. East Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E095	20	10.9	5.5	5.4	49.5
	35	6.91	9.28	-2.37	-34.3
	52	1,880	< 5	1,875	99.7
	60	5.46	75	-69.54	-1,273.6
	80	8.08	20.2	-12.12	-150.0
E097	35	< 4.98	36	-31.02	-622.9
E098	20	< 5.03	< 4.99	0.04	0.8
	35	< 5.02	< 5.01	0.01	0.2
E099	35	6.37	< 5.02	1.35	21.2
E100	20	7,820	< 5	7,815	99.9
	35	1,860	< 5.02	1,854.98	99.7
E102	20	27.9	< 4.99	22.91	82.1
	35	30.5	7.73	22.77	74.7
E103	20	< 4.99	< 5	-0.01	-0.2
	35	< 5.01	< 5.02	-0.01	-0.2
	52	< 5.02	< 5.01	0.01	0.2
E104	20	< 4.97	< 5.01	-0.04	-0.8
	35	196	9.4	186.6	95.2
E105	35	< 5	< 5	0	0
E106	20	20	315	-295	-1,475
	35	< 5	9.15	-4.15	-83
E107	35	60.2	118	-57.8	-96
E110	20	8.46	< 5.03	3.43	40.5
	35	10.6	46.1	-35.5	-334.9
	52	2,610	5.23	2,604.77	99.8
Count		25	25		
Average (µg/kg)		584	29		95
Minimum (µg/kg)		4.97	4.99		
Maximum (µg/kg)		7,820	315		
Count < 70 µg/kg		20	22		
Count nondetectable		9	16		

[1] Difference of baseline and post operational samples

[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

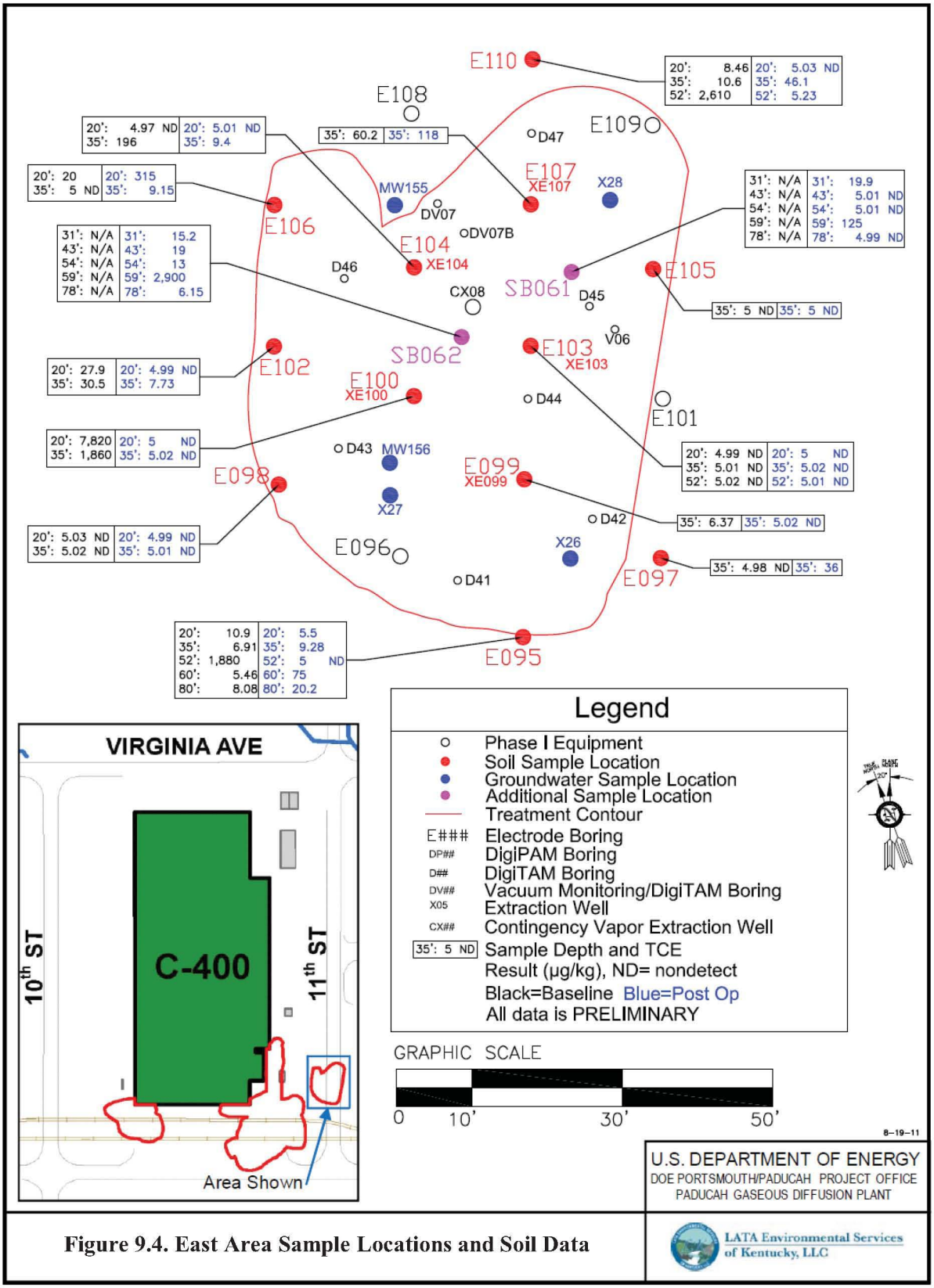

Figure 9.4. East Area Sample Locations and Soil Data

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E003	20	< 5.01	< 5.01	0	0
E003	35	< 4.97	< 4.97	0	0
E006	20	6.31	< 5.02	1.29	20.4
E006	35	176	< 5.01	170.99	97.2
E006	52	373	< 4.98	368.02	98.7
E006	60	< 5.03	< 5	0.03	0.6
E006	80	< 5.01	13.2	-8.19	-163.5
E006	103	< 4.99	< 5.02	-0.03	-0.6
E007	20	< 5.02	< 5.04	-0.02	-0.4
E007	35	< 4.97	< 5.02	-0.05	-1
E007	52	124	< 5.03	118.97	95.9
E007	60	21.2	< 5.01	16.19	76.4
E007	80	< 5	< 4.98	0.02	0.4
E007	103	8.94	< 5	3.94	44.1
E009	20	12.3	< 4.98	7.32	59.5
E009	35	8,670	< 5.03	8,664.97	99.9
E010	20	1,010	< 5.03	1,004.97	99.5
E010	35	3,590	< 5.03	3,584.97	99.9
E010	52	873	< 5.01	867.99	99.4
E010	60	15	5.31	9.69	64.6
E010	80	< 5.01	< 5.03	-0.02	-0.4
E010	103	< 4.98	14.5	-9.52	-191.2
E011	20	5,720	< 5.02	5,714.98	99.9
E011	35	1,230	< 5.04	1,224.96	99.6
E011	52	5,240	5.01	5,234.99	99.9
E011	60	7,860	11	7,849	99.9
E011	80	14	8.14	5.86	41.9
E011	103	17.3	< 5.04	12.26	70.9
E012	20	99.5	< 5.03	94.47	94.9
E012	35	6,590	< 5.01	6,584.99	99.9
E012	52	14,500	< 5	14,495	100
E012	60	469	< 5.02	463.98	98.9
E012	80	195	38.1	156.9	80.5
E012	103	< 5.03	< 5.01	0.02	0.4
E013	20	7.09	< 5.02	2.07	29.2
E013	35	50.1	34	16.1	32.1
E016	20	< 5.03	18.8	-13.77	-273.8

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E016	35	28.9	< 5.03	23.87	82.6
E017	20	607	< 5.02	601.98	99.2
E017	35	3,770	< 5.02	3,764.98	99.9
E017	52	55.7	< 5.03	50.67	91
E017	60	< 46.3	< 4.99	41.31	89.2
E017	80	< 49.3	< 5.04	44.26	89.8
E017	103	< 4.97	< 5.01	-0.04	-0.8
E018	20	676	92.6	583.40	86.3
E018	35	522	14.3	507.70	97.3
E018	52	323	< 5.02	317.98	98.4
E018	60	706	228	478	67.7
E018	80	< 5.01	< 5.01	0	0
E018	103	6.57	< 5	1.57	23.9
E019	20	11.9	68.9	-57	-479
E019	35	69.7	< 4.98	64.72	92.9
E019	52	1,900	13.8	1,886.2	99.3
E020	20	120	< 5.04	114.96	95.8
E020	35	< 5.04	9.93	-4.89	-97
E026	20	26.7	< 4.99	21.71	81.3
E026	35	< 5	27.2	-22.2	-444
X06	20	< 5.02	< 5.03	-0.01	-0.2
X06	35	< 5.03	< 4.99	0.04	0.8
X06	52	< 5.03	88	-82.97	-1,649.5
X06	60	14.5	7.88	6.62	45.7
X06	80	< 5.03	24.6	-19.57	-389.1
X06	103	< 4.99	12.7	-7.71	-154.5
Count		63	63		
Average (µg/kg)		1,046	15		99
Minimum (µg/kg)		4.97	4.97		
Maximum (µg/kg)		14,500	228		
Count <70 µg/kg		39	60		
Count nondetectable		23	43		

[1] Difference of baseline and post operational samples
[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

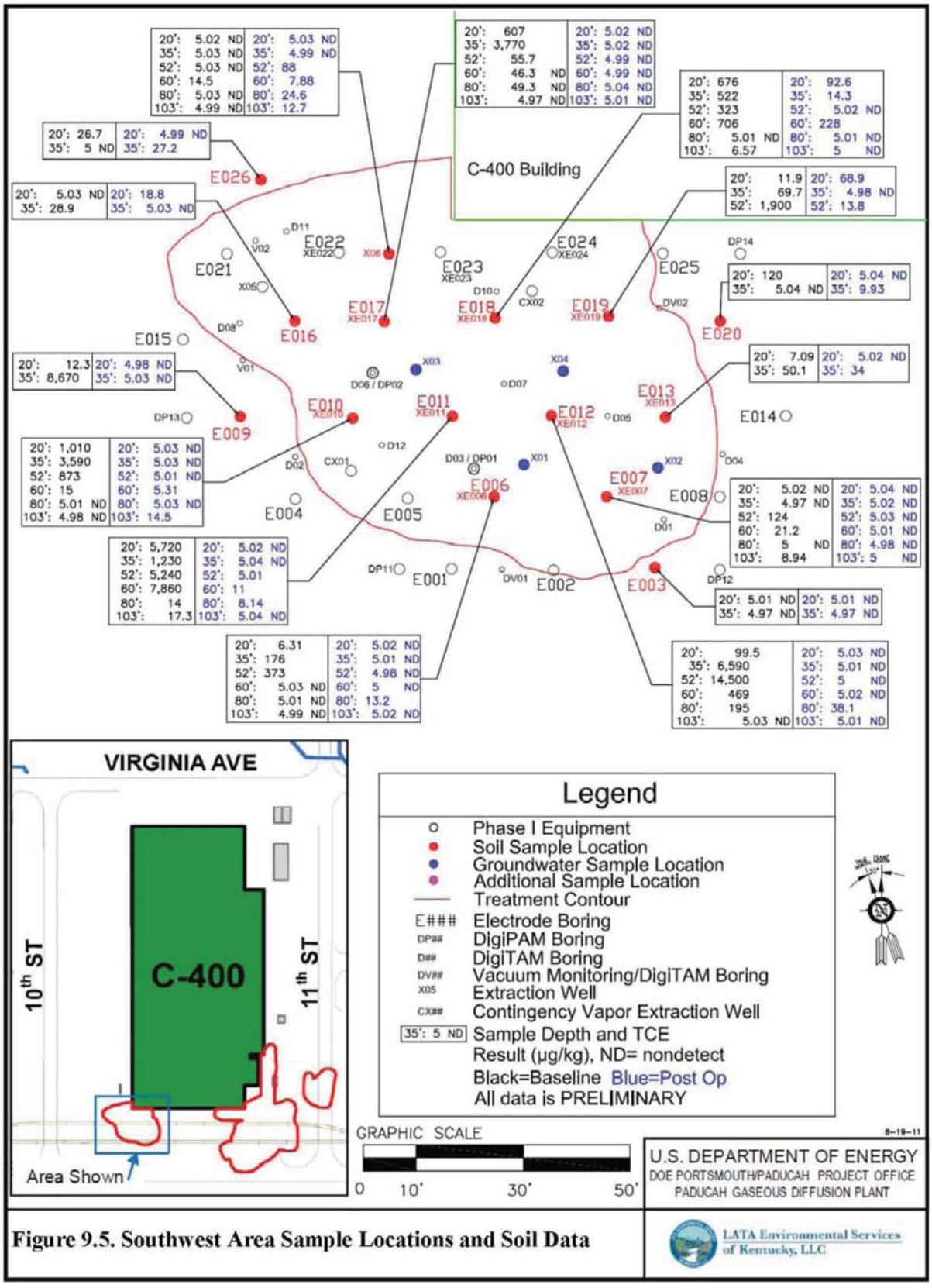

Figure 9.5. Southwest Area Sample Locations and Soil Data

groundwater through the target volume). A 2010 ITR assessment of Phase I (ITR 2010) concluded that Phase II should implement ERH for the UCRS, but noted that, based on the Phase I results, ERH (or any of the other thermally enhanced removal technologies) is poorly matched to the RGA conditions in the vicinity of the C-400 Building. As an interim action, the ITR recommended modification of the existing water treatment infrastructure for Phase II support (to reduce unnecessary costs) and implementation of pump-and-treat of contaminated groundwater from the RGA in the Phase II RGA target zone.[3] The ITR recommended that heating technology be eliminated from Phase II for the RGA. Instead, the ITR recommended using a technology that is better matched to the RGA, such as oxidation using chemical reagents or solubilization using cosolvents or surfactants.

The Phase I ERH action effectively removed UCRS contamination associated with a former break in a sewer pipe to the east of C-400 and associated with an unknown source at the southwest corner of C-400. The upcoming Phase II ERH action is anticipated to reduce effectively the remaining VOC contamination in the UCRS to the south and southeast of C-400. This IRA will be protective of the site worker.

9.5 ISSUES

The ROD selected ERH to address the VOC source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting the RAOs in the Upper Continental Recharge System and the upper RGA; however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.

[3] Preliminary ITR calculations indicate that pump--and-treat in the Phase II RGA target zone would remove contamination at rates that are on par with the Phase I RGA system, while substantially reducing the potential for adverse impacts.

10. SOUTHWEST PLUME

The Southwest Plume project currently is underway. The scope of this project is to implement selected remedies for some of the known VOC sources to the Southwest Plume. This project is included in this Five-Year Review with summaries of activities consistent with the progress of the project up to the date of the review. The ROD was signed in April 2012; therefore, less than a year time frame is included in this evaluation.

DOE conducted an SI of the Southwest Plume and four potential source areas in 2004 [*Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2007)]. Then a Focused Feasibility Study for the Southwest Groundwater Plume VOC Sources (Oil Landfarm and C-720 Northeast and Southeast Sites) was conducted (DOE 2012b).

The Southwest Plume consists of groundwater in the RGA contaminated primarily with TCE, a VOC, and is located within the DOE property, west of the C-400 Building and south of the larger groundwater contamination area identified as the Northwest Plume. Sources to the Southwest Plume included in this action are the SWMU 1 Oil Landfarm, SWMU 211-A C-720 Building TCE Northeast Spill Site, and the SWMU 211-B C-720 Building TCE Southeast Spill Site.

10.1 REMEDY SELECTION

The ROD for these SWMUs implements deep soil mixing to treat the VOC source zone at SWMU 1 and field data collection followed by either enhanced *in situ* bioremediation or long-term monitoring for SWMUs 211-A and 211-B (DOE 2012c).

The SWMU 1 remedial action includes an RDSI to determine the extent and distribution of VOCs in the UCRS, implementation of deep soil mixing with injection of steam and zero valent iron, confirmatory sampling, site restoration, and groundwater monitoring. The remediation goal for TCE (the primary VOC) for this action, as documented in the ROD (DOE 2012c), is to reduce average TCE levels in the UCRS soil to below 0.073 mg/kg over an estimated remediation time frame. DOE will refine the design, based on the TCE mass at SWMU 1, as determined from the RDSI, to meet the remedial action goals. Implementation of deep soil mixing is planned for calendar year 2014.

The SWMUs 211-A and 211-B remedial actions begin with a FC/RDSI for each site. Based on the results of the FC/RDSI, the FFA parties will select for each of the SWMUs either treatment (*in situ* source treatment using enhanced *in situ* bioremediation) or long-term monitoring. The selection of the remedial action for the C-720 sites will be based upon the results on the FC, a comparison of current and historical VOC contaminant levels, and an estimation of the time required to achieve cleanup goals. The remediation goal for TCE (again, the primary VOC) for the actions at SWMUs 211-A and 211-B is to reduce average TCE levels in the UCRS soil to below 0.075 mg/kg.

The response actions selected in this ROD provide for timely remediation of VOCs at the Southwest Plume sources. Deep soil mixing at SWMU 1 will volatilize contaminants in the groundwater and soil. The volatilized contaminants are captured by vacuum in a shroud that extends over the auger zone and leads to aboveground equipment for processing and later disposal as hazardous waste. Enhanced *in situ* bioremediation destroys the contaminants in place.

This ROD designates the high-concentration-TCE soils and residual TCE DNAPL as principal threat waste. The RAOs in the ROD are as follows:

- Treat and/or remove the principal threat waste consistent with the National Oil and Hazardous Substances Pollution Contingency Plan.

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

- Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending final remedy selection as part of a subsequent OU that addresses the relevant media.

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

10.2 REMEDY IMPLEMENTATION

The SWMU 1 RDSI was conducted in accordance with the RDSI Characterization Plan found in *Remedial Design Work Plan for Solid Waste Management Units 1, 211-A, and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1268&D2/R2, during July and August 2012 using direct push technology (DPT) sampling (DOE 2012d). DPT provides a continuous soil core while minimizing the generation of investigation-derived waste. The RDSI sampled 24 DPT soil borings (with preliminary next-day VOC results) to a depth of 60 to 65 ft (top of the RGA gravel member or depth of refusal) to determine the extent of the VOC source zone at SWMU 1 (see Figure 10.1). The DPT soil cores provided for sampling in each 5-ft depth interval for VOCs, sampling for geotechnical testing, and logging of soil texture. The extent of the VOC source zone delineated during the RDSI is being used by the design team to optimize the placement and spacing of the deep soil mixing borings. The 30% and 60% RDRs, DOE/LX/07-1276&D1, were issued in June and September 2012, respectively.

Well installation and soil sampling for the SWMU 211-A and 211-B FC/RDSI began in August 2012 in accordance with the RDSI Characterization Plan (DOE 2012e). The project crew completed DPT sampling, as done at SWMU 1, and well testing at SWMU 211-B in October 2012. The characterization of extent at SWMU 211-B required 19 DPT soil borings (Figure 10.2). Sampling activities at SWMU 211-A are continuing into 2013. Through 2012, the characterization of extent at SWMU 211-A had required 34 DPT soil borings (Figure 10.3). Additional characterization is required to define the extent of VOC-contaminated UCRS soil to the west of the existing SWMU boundary. Results from the FC/RDSI will be reported in a Field Characterization Report in 2013.

As required by the ROD, the ROD was made available to the organization responsible for implementing the Excavation/Penetration Permit Program within 30 days of the ROD signatures. Warning signs also were posted for the Southwest Plume source areas before beginning RDSI field activities. Signs were removed once RDSI fieldwork was completed. DOE will repost areas before remedial action field activities resume that involve worker exposure to contaminated groundwater or soil.

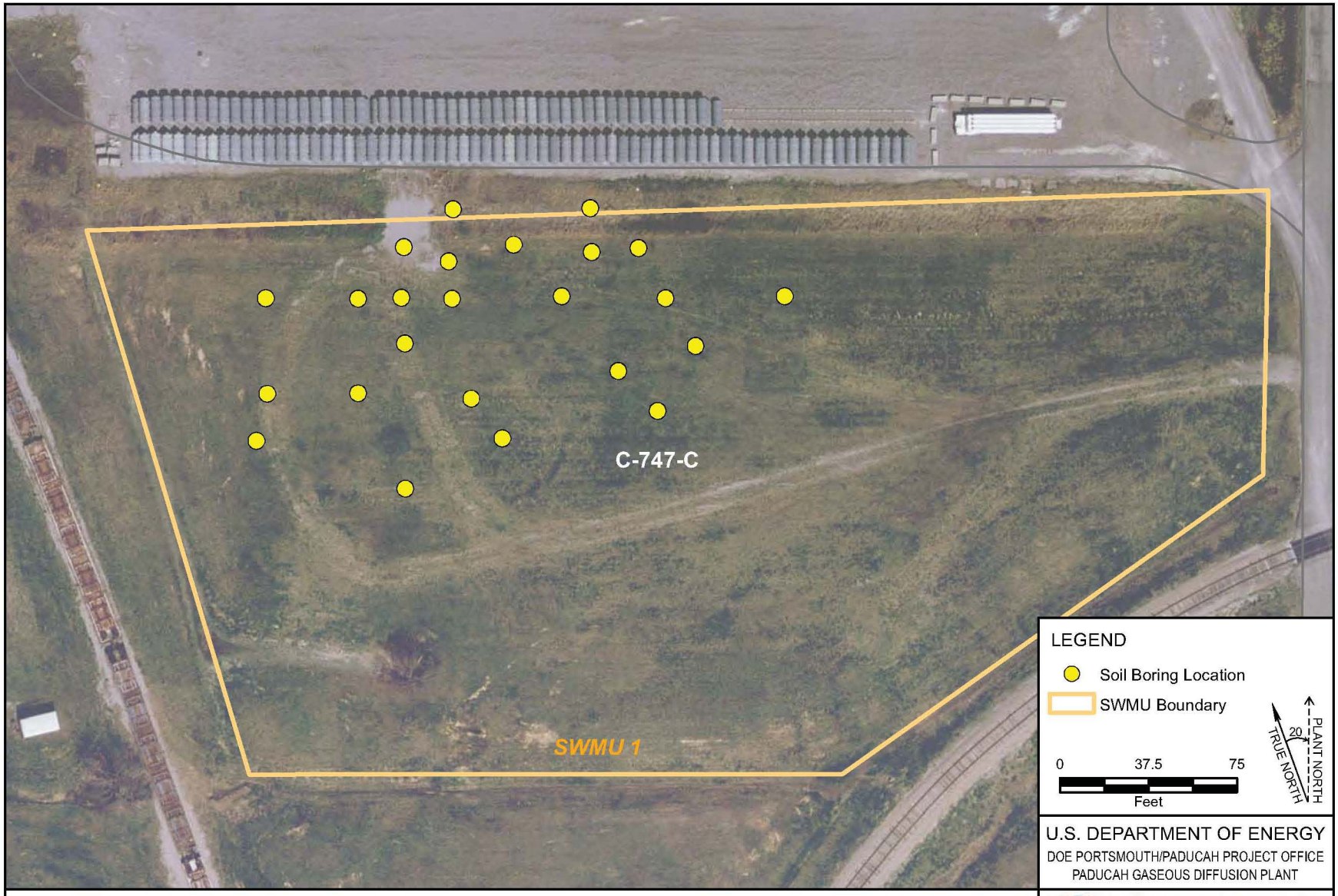

Figure 10.1. 2012 RDSI Sample Locations at the C-747-C Oil Landfarm

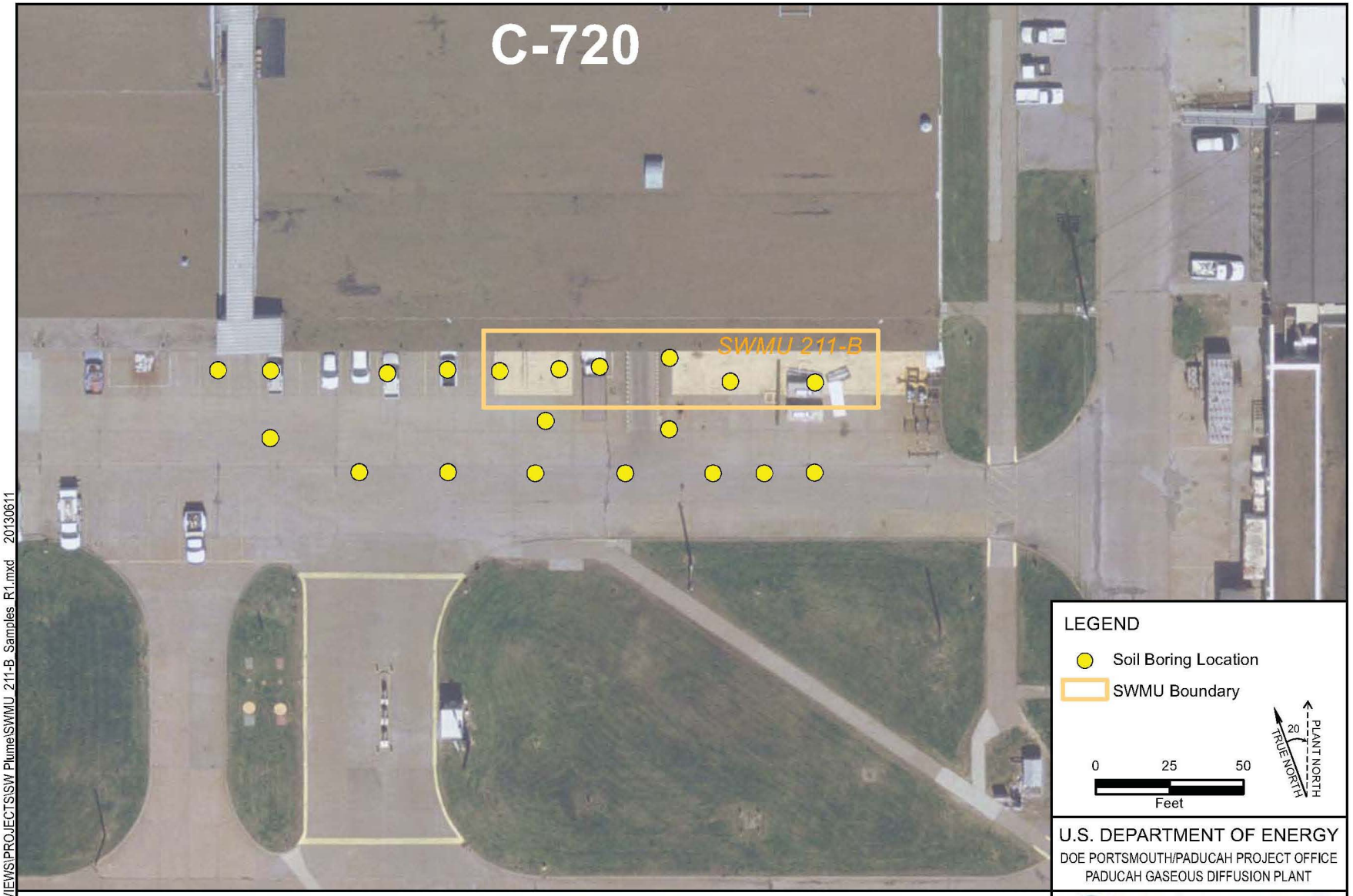

Figure 10.2. 2012 RDSI Sample Locations at SWMU 211-B

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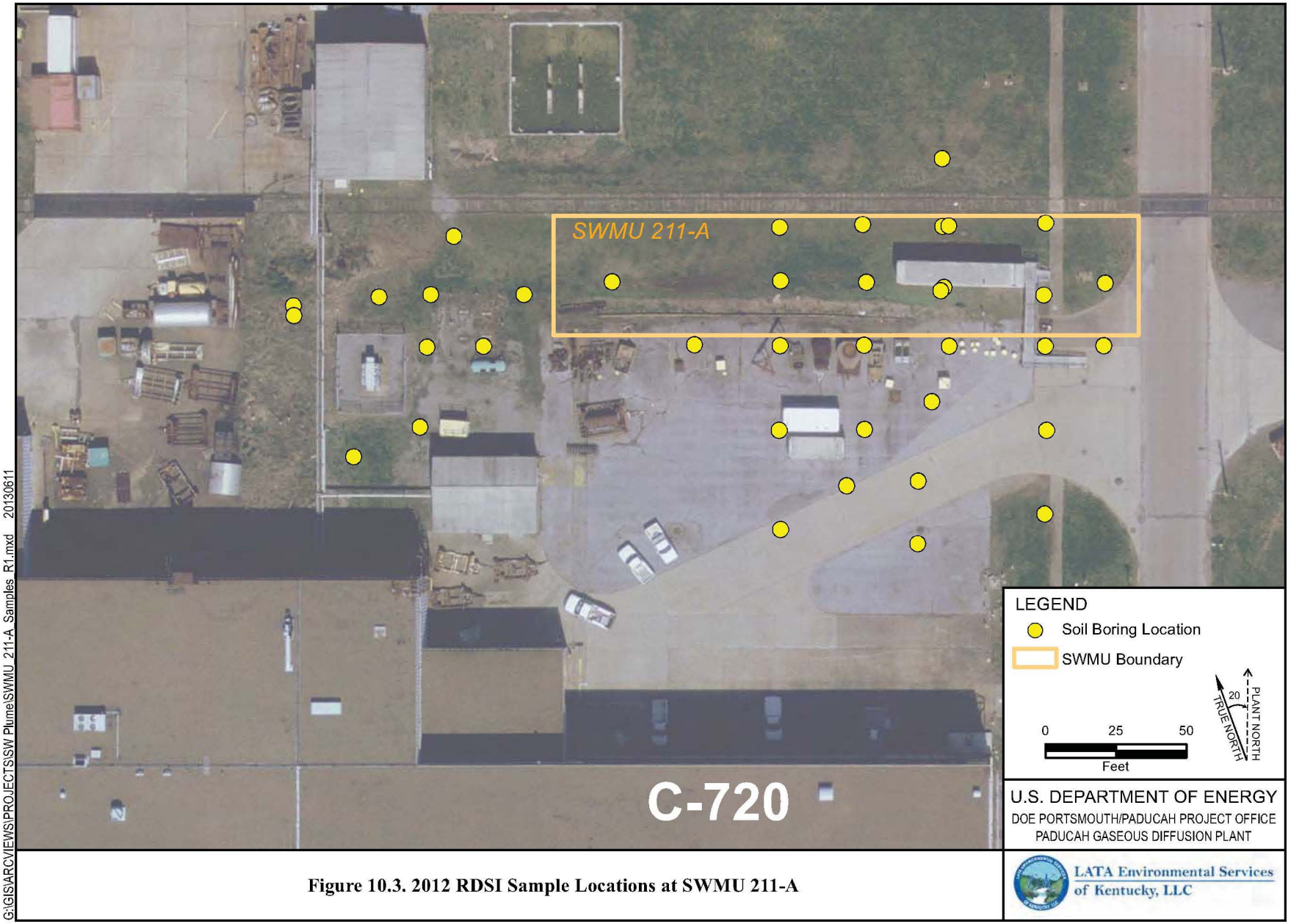

Figure 10.3. 2012 RDSI Sample Locations at SWMU 211-A

10.3 PRELIMINARY TECHNICAL ASSESSMENT

The area of UCRS soil contamination at the C-720 Building Southeast Site is near the outlet to one of the storm drains for the east end of the C-720 Building. There also is a storm sewer inlet for the southeast parking lot in the vicinity. The northern edge of the this parking lot where the contamination occurs, also is the location of one of the loading docks for the C-720 Building, an area where chemicals, including solvents, may have been loaded or unloaded. The VOCs associated with this site, which are beneath the southeast parking lot, may be the result of activities within the building that resulted in VOCs entering the storm drains for the southeast corner of the building or from spills or leaks of activities on the loading dock or in the southeast parking lot. The subsurface soil contamination found to the northeast of the C-720 Building is believed to have been a result of routine equipment cleaning and rinsing with solvents.

The C-747-C Oil Landfarm was used for landfarming of waste oils contaminated with TCE, uranium, PCBs, and 1,1,1-trichlorethane between 1973 and 1979. These waste oils are believed to have been derived from a variety of plant processes. The Landfarm consisted of two 1,125 ft^2 plots that were plowed to a depth of 1 to 2 ft. Waste oils were spread on the surface every 3 to 4 months, then the area was limed and fertilized. The VOC contamination in the soils at C-747-C is thought to be the residual of the waste oils.

These activities, or other unknown spills, have resulted in VOC-contamination. PGDP's contractor excavation/penetration permit program and the DOE Water Policy limit the exposure pathways to the SWMU 1 and C-720 area source zones. The confined space air characterization summarized in the introduction to Section 9 indicates that vapor inhalation likely is not a significant concern associated with these source zones.

It is anticipated that the upcoming Southwest Plume source actions will be protective.

10.4 ISSUES

None.

11. NSDD SOURCE CONTROL

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. Figure 11.1 illustrates the location of the NSDD Source Control. Historically, the NSDD received wastewater from the C-400 Cleaning Building that houses equipment for decontamination, metal etching and plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and uranium tetrafluoride (UF_4) pulverization. Additional sources of runoff to the ditch include the C-600 Steam Plant, the C-335 and C-337 Process Buildings, the C-635 Cooling Tower, and the C-535 and C-537 Switchyards. As a consequence, the soil and sediment in the ditch were contaminated with radionuclides, metals, and PCBs. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed had nearly filled the NSDD causing the ditch to overflow onto an adjacent stretch of 10th Street at PGDP during heavy rains.

The 2008 Five-Year Review determined that the exposure pathways for the NSDD Control Source that could result in unacceptable risk are being controlled and therefore are protective of human health and the environment. The following is from the 2008 review.

> The remedy for the NSDD Source Control is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled.
>
> This project was not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

11.1 REMEDY SELECTION

In March 1994, DOE and EPA, with the concurrence of KDEP, signed a *Record of Decision for Interim Action Source Control at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1213&D3, as an initial step toward addressing sitewide problems (DOE 1994c).

The PHEA found that the critical exposure pathway is related to the off-site (i.e., outside the existing security fence) migration of on-site contaminant sources (CH2M HILL 1992). The PHEA also recommended action to eliminate the off-site (i.e., outside the existing security fence) migration of these contaminants to the outside of the Paducah Gaseous Diffusion Plant's boundaries (i.e., outside the existing security fence) and recommended remedial action to eliminate this off-site (i.e., outside the existing security fence) movement. The NSDD ROD also stated there was potential for exposure of plant maintenance personnel to the contaminants within the ditch through routine maintenance activities. The personnel were potentially exposed to unacceptable risk via direct gamma radiation from contaminated sediment and soil; dermal contact with soil, sediment, and debris; inhalation of resuspended particulate during mowing; and incidental ingestion of contaminated surface water, soil, and sediment. The source control remedial action and the response actions for Sections 1 and 2 (as discussed in Chapter 12) eliminated exposure pathways. In addition, aquatic organisms living in the NSDD likely were at risk from adverse effects that could reduce populations. Predators of aquatic organisms also may have been at equivalent levels of risk due to bioaccumulation of PCBs.

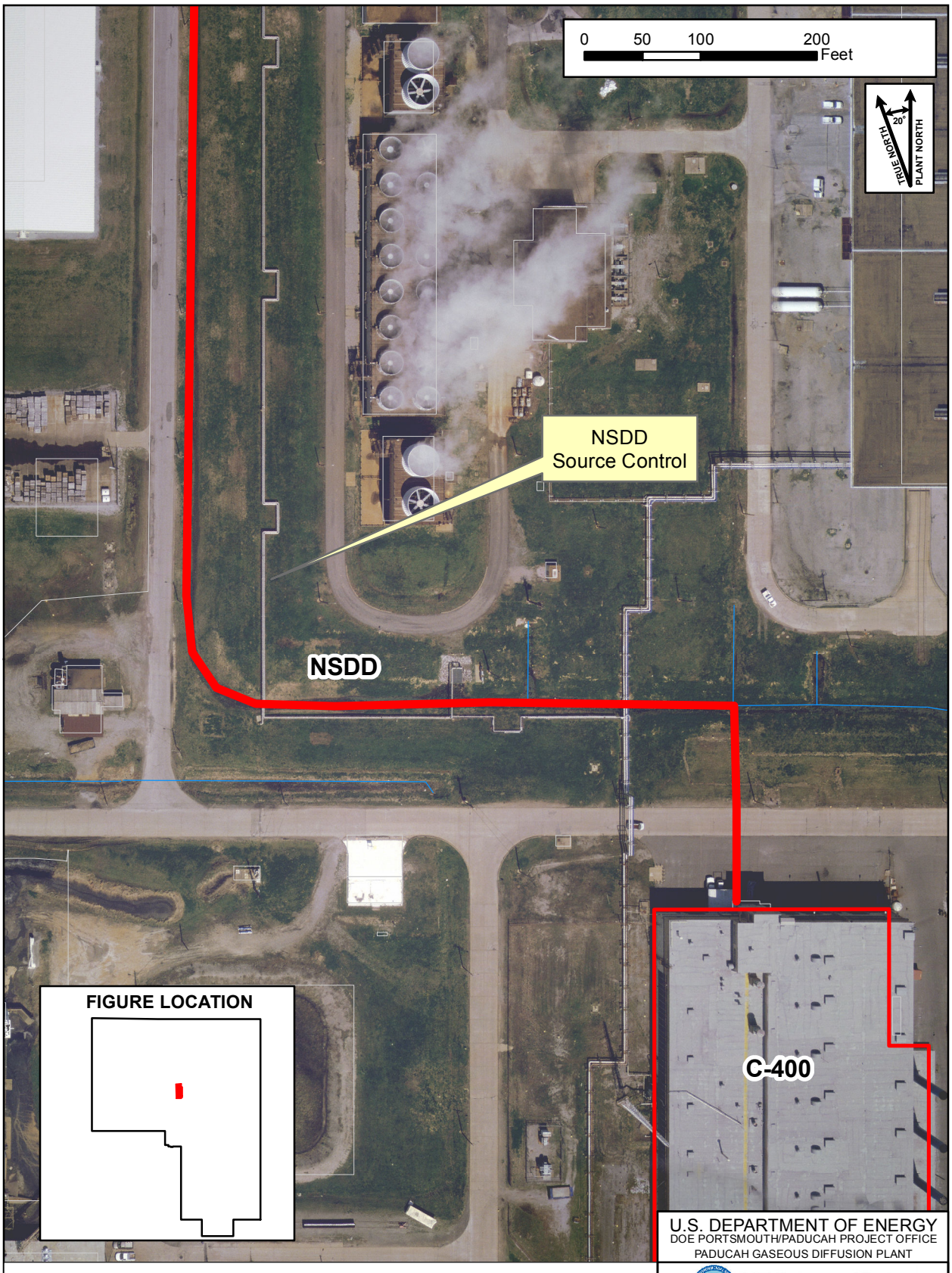

Figure 11.1. Location of NSDD Source Control

The RAOs of the interim action were the following:

- Mitigate the introductive of contaminants into the NSDD;
- Decrease the migration of contaminants already present in the NSDD; and
- Decrease the potential for direct contact with the contaminated material.

11.2 REMEDY IMPLEMENTATION

The IRA consisted of the following activities:

- Installing an ion exchange system in the C-400 Building;

- Rerouting effluent from the C-400 Building from the NSDD to Outfall 008;

- Constructing an aboveground pipe and lift stations (C-400-L and C-616-L) and pumping NSDD flow along the aboveground pipeline to the existing C-616-H Lift Station;

- Removing fly ash from the C-600 Steam Plant ash pile runoff by constructing settling lagoons then pumping the supernatant in the lagoons into the piping that replaced the southern part of the NSDD channel;

- Constructing a gabion to trap sediment and reducing the potential for sediment transport off-site (i.e., outside the existing security fence) from the NSDD; and

- Installing warning signs on both sides of the NSDD inside the security fence from Virginia Avenue to the C-616-C Lift Station to provide notice of elevated levels of radionuclides, metals, and PCBs in the area. These signs were removed upon successful completion of the response action for the NSDD Sections 1 and 2, which is discussed in Chapter 12.

DOE completed the IRA during August 1995 (DOE 1995c). Once construction was completed, two components of the actions, the C-400 Ion Exchange and C-600 Fly Ash Lagoons, were incorporated into the daily operations of PGDP by USEC. Also, the discharge from the C-400 Ion Exchange system was routed to the Outfall 008 stormwater drain thereby eliminating discharges from the C-400 Building to the NSDD. Lagoons constructed at the C-600 Steam Plant eliminated fly ash deposition in the NSDD. Since completion of the NSDD Source Control IRA, a second ROD for IRA at the NSDD was signed on September 25, 2002, which is discussed in Chapter 12.

The 1994 NSDD ROD identified ARARs pertinent to the remedial action (DOE 1994a). The 1998 Five-Year Review found that jurisdictional wetlands have been identified in the NSDD after the ROD had been signed. The 1994 ROD for the NSDD was signed prior to DOE's Secretarial Policy requiring that National Environmental Policy Act values be incorporated in CERCLA documents (DOE 1994a). DOE complied with all requirements during implementation of the remedial action and continues to comply with identified requirements during operation of the action. Because the wetlands were not identified prior to signing the 1994 ROD, ARARs for the protection of wetlands were not identified. They were added in 2003 during the five-year review period and are being complied with.

11.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The O&M requirements were previously documented in the *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c) but are now documented in *Operation and Maintenance Plan for Sections 1 and 2 of the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2005c). The primary activities associated with O&M include the following:

- Inspecting lift stations weekly (fully automated) to ensure the lift station screens remain clean, the lift stations are operational, and the pipeline is not leaking;
- Activating heat tracing installed on the aboveground piping in the fall and deactivating it in the spring and inspecting weekly;
- Inspecting quarterly the warning signs that were put in place when the ROD was developed; and
- Mowing the area adjacent to the pipeline and warning signs twice during the summer months.

The operations of the C-400 Ion Exchange unit and discharges from it are conducted according to a memorandum of understanding between USEC and DOE.

On February 19, 2013 a site inspection of the following facilities associated with the NSDD IRA was conducted: (1) the C-400-L Lift Station and associated piping, (2) the C-616-L Lift Station and associated piping, and (3) the gabion installed at the C-616-H Lift Station. Additionally, the signs that had been posted along the southern reaches of the ditch were removed after the remedial response for Sections 1 and 2 (Chapter 12) was completed.

The C-400-L Lift Station is located on the north side of the NSDD near its upper reach near the intersection of 10th Street and Virginia Avenue. It is included in the radiological boundary posting along the NSDD. With the exception of a gravel walkway, access to the station electrical control panels and the east side of the lift station is restricted. The lift station is in good condition and appears to be functioning normally. During this inspection, there were no visible indications that the street or walkways along the ditch have been flooded in the recent past. The inlet grating to the lift station was free of excessive debris, although there were some cattails and standing water in front of the inlet grating. The lift station did not run during this inspection, due to minimal water flow in the ditch. The electrical power and control panels and associated conduits located just east of the lift station are in good condition. In 2009, extensive re-wiring was completed for the lift station to accommodate new level probes and relays that were installed. The previous level probes had begun to malfunction, which resulted in the occasional need for manual pumping of the lift station.

The C-616-L Lift Station is located on the south side of Virginia Avenue and north of the C-600 Steam Plant. This lift station collects coal pile runoff and fly ash settling basin water from C-600. Water from the fly ash settling basins enters the station through underground piping from the basins. Coal pile runoff is routed into the west side of the lift station by a trench. This lift station is under the control and operation of USEC. During this inspection, the lift station was functioning as designed. There were no indications of water overflow in the vicinity of the lift station. Water levels in the settling basins were normal. Power and control panels associated with the lift station are rusting but intact.

The discharge piping from the C-400-L and C-616-L Lift Stations, which is mounted on abovegrade concrete and steel pipe supports, originally routed water around the more contaminated southern-most reaches of the NSDD to a point just south of Outfall 001. To facilitate the remediation of Sections 1 and 2

of the NSDD, this piping was extended, both aboveground and underground, to a point just north of the C-616-C Lift Station inlet. The piping appears in good condition, with no evidence of leaks, and is performing as designed. The aboveground piping insulation was in good condition and intact; the metal jacket covering was not rusted or deteriorated; however, several small pieces of covering were damaged, partially attached, or missing.

A gabion with a nonwoven, geotextile filter was installed at the existing C-616-H Lift Station located on the east side of 10th Street and north of the C-400-L and C-616-L Lift Stations. This sediment trap was installed to reduce the potential for sediment transport off-site (i.e., outside the existing security fence) from the NSDD. During this inspection, the gabion appears to be in good condition and is functioning as designed.

The costs associated specifically with O&M activities are not accounted for separately, because they are performed as part of the plantwide, long-term surveillance and maintenance, and environmental monitoring programs.

11.4 TECHNICAL ASSESSMENT

The ion exchange system was installed in the C-400 Cleaning Building to treat elevated levels of radionuclides in effluent being released from the C-400-B Storage Tank. USEC leased the C-400 Building and its operations from DOE in 1993. The C-400 Ion Exchange system effluent is routed to the USEC-operated C-400 Cleaning Building collection tank, where it is stored until the treatment levels are assessed. The wastewater is repeatedly processed through the uranium precipitation and ion exchange systems until a point of diminishing return is reached (i.e., until the percentage of reduction becomes insignificant with subsequent treatments). The final concentration in the treated water is contingent upon the initial concentrations. After treatment, the water either is recycled in C-400 Building processes or is discharged via Outfall 008. Because the effluent discharge from the C-400 Building is treated until a point of diminishing return is reached and was rerouted to Outfall 008 during the design phase, the introduction of contaminants into the NSDD from the C-400 Building has been eliminated completely.

The discharges of Outfall 008 are the responsibility of USEC. The wastewater from the C-400 Building is treated and DOE monitors surface water at Outfall 008 quarterly as a part of its Environmental Monitoring Program. From 2005 to 2010, this location was monitored for volatiles, PCBs, metals, anions/cations, and radionuclides. Since 2011, this location has been monitored for volatiles and PCBs. The maximum Tc-99 detection during this review period is 20.1 pCi/L, which is considerably less than the accepted standards.

Two concrete settling lagoons were constructed to reduce fly ash from the C-600 Steam Plant ash pile runoff prior to discharge. The C-600 Fly Ash Lagoons continue to be used to keep coal-pile water runoff out of the NSDD, thereby lowering the levels of sediment being deposited in the NSDD. With the installation of the two lift stations, C-400-L and C-616-L, and associated aboveground and underground pipelines to bypass coal-pile water runoff and fly ash settling basin water to the NSDD, the introduction of contaminants into the NSDD from the C-600 Steam Plant has been eliminated completely. The lift stations appear to be functioning properly. After the site inspection, maintenance on the aboveground pipeline metal jacket covering was completed.

To minimize sediment transport off-site (i.e., outside the existing security fence) from the NSDD, a gabion with a nonwoven, geotextile filter was installed. The gabion is functioning as designed.

11.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. Based upon the site inspection, the NSDD IRA is meeting the remedial objectives as stated in the ROD.

11.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that the NSDD Source Control encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD remains valid.

Changes in risk assessment methodology subsequent to approval of the ROD have been significant; however, successful implementation of the second IRA for the NSDD (discussed in Chapter 12) has eliminated exposure pathways, thereby eliminating the risk to human health and the environment. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal of the impacted soils.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

11.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

11.4.4 Technical Assessment Summary

The Sections 1 and 2 O&M Plan requires weekly inspections to ensure that the screen of the Ditch 001 lift station remains clean; that all of the lift stations are operational; and that the pipeline is not leaking.

The primary risk driver and objective for the interim action was that personnel potentially were exposed to unacceptable risk via direct gamma radiation from contaminated sediment and soil; dermal contact with soil, sediment, and debris; inhalation of resuspended particulate during mowing; and incidental ingestion of contaminated surface water, soil, and sediment. The interim action is functioning as designed and therefore is protective of human health and the environment.

11.5 ISSUES

None.

12. NSDD SECTIONS 1 AND 2

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. Figure 12.1 illustrates the location of the NSDD Sections 1 and 2 (SWMU 59). Historically, the NSDD received wastewater from the C-400 Cleaning Building that houses equipment for decontamination, metal etching and plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and UF_4 pulverization. Additional sources of runoff to the ditch include the C-600 Steam Plant, the C-335 and C-337 Process Buildings, the C-635 Cooling Tower, and the C-535 and C-537 Switchyards. As a consequence, the soil and sediment in the ditch were contaminated with radionuclides, metals, and PCBs. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed had nearly filled the NSDD causing the ditch to overflow during heavy rains onto an adjacent stretch of 10th Street at PGDP.

According to the NSDD ROD, there was potential for exposure of industrial worker to the contaminants within the ditch through routine maintenance activities (DOE 2002d). The personnel were exposed to unacceptable risk via direct gamma radiation from contaminated sediment and soil; dermal contact with soil, sediment, and debris; inhalation of resuspended particulate during mowing; and incidental ingestion of contaminated surface water, soil, and sediment. The source control remedial action (as discussed in Chapter 11) and the response actions for Sections 1 and 2 eliminated exposure pathways.

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the NSDD Sections 1 and 2 is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

12.1 REMEDY SELECTION

Risks associated with the NSDD are presented in *Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-1948&D2. According to the NSDD ROD, there was potential for exposure of plant maintenance personnel to the contaminants within the ditch through routine maintenance activities (DOE 2002d).

The RAOs for Phase II were as follows:

- Prevent future discharge of process waste to the NSDD;

- Reduce the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water to acceptable levels by eliminating direct exposure to contaminated media at the NSDD; and

- Prevent future on-site (i.e., inside the existing security fence) run-off from being transported off-site (i.e., outside the existing security fence) via the NSDD.

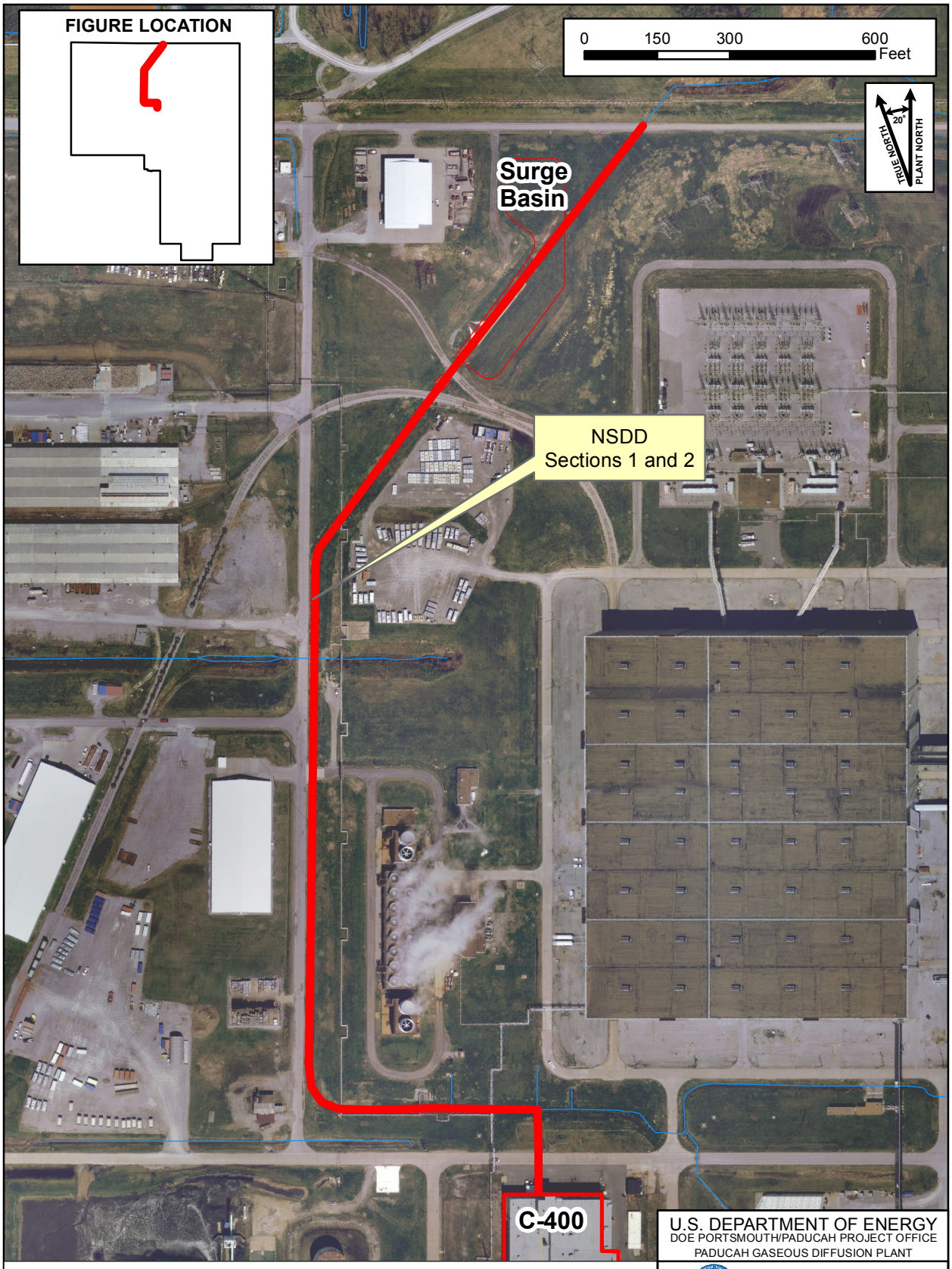

Figure 12.1. Location of NSDD Sections 1 and 2

The LUC objective identified to assure the protectiveness of the preferred alternative for Sections 1 and 2 of the NSDD is as follows:

- Sections 1 and 2 (Industrial areas)—Restrict unauthorized access, restrict unauthorized excavations or penetrations below prescribed contamination cleanup depth, and restrict uses of the area that are inconsistent with the assumed industrial use (i.e., to prevent recreational and/or residential use).

12.2 REMEDY IMPLEMENTATION

A remedy for Sections 1 and 2 of the NSDD was implemented and completed in 2004. The NSDD Sections 1 and 2 remedy consisted of the following components:

- Excavate contaminated soils/sediments along Sections 1 and 2 of the NSDD, located inside the PGDP security-fenced area, to achieve specified cleanup levels. After the ditch was excavated to a 4 ft depth and confirmation sampling had occurred, a 2 ft clay cover was installed at the base of the excavation.

- Stage and dispose of contaminated excavated materials. Wastes generated as a result of the NSDD remedial action were disposed in the C-746-U Landfill.

- Restore Sections 1 and 2 of the NSDD to grade with 2 ft of clay cover, approximately 2 ft of clean soil, and vegetation following completion of excavation activities. The clay cover provides an extra layer of protection for eliminating the surface exposure pathway. The original plan was that if excavation achieved or exceeded the specified cleanup levels for Sections 1 and 2, long-term maintenance of the clay cover would not be required. The specified clean-up levels were achieved; therefore, the clay cover is not maintained to prevent exposure.

- Construction of a detention basin to capture storm flow along the ditch and prevent it from transporting contaminated sediment beyond the fence boundary. This included plugging drainage culverts so that neither water nor sediment can leave the PGDP through the ditch. The water that is caught by the detention basin is diverted to the C-616 Treatment Facility and lagoon where it is discharged through Outfall 001.

- Implementation of LUCs to restrict unauthorized access, restrict unauthorized excavation or penetrations below prescribed contamination cleanup depths, and restrict use of the area that is inconsistent with the assumed industrial use (i.e., to restrict recreational and/or residential use).

Implementation of LUCs designed to meet these objectives was documented in a LUCIP (DOE 2003b). DOE is responsible for implementing, maintaining, monitoring, reporting on, and enforcing the LUCs selected under the ROD.

During the planning phases of this response action, additional waste characterization efforts were initiated at the direction of the Kentucky Division of Waste Management (KDWM). These extra sampling activities included field analyses for PCBs and volatile organics in soil. These analyses ensured that waste soils met the waste acceptance criteria for the C-746-U Landfill.

As part of the implementation of the NSDD Sections 1 and 2 Project, the EPA required an evaluation of the C-746-U Landfill to ensure that waste from the NSDD that was disposed there would not pose unacceptable risks to human health and the environment. This requirement was provided in a letter dated April 24, 2003, and stated the following:

> …because the disposal in the landfill from the NSDD interim action is expected to leave levels of contamination – both within the remediated NSDD area and on-site in the C-746-U Landfill disposal area – above levels that allow for unrestricted use and unlimited exposure, the five-year reviews required to ensure protectiveness of this action must examine conditions in both these areas to insure that the entire action remains protective (EPA 2003).

The C-746-U Landfill is a contained landfill as defined in Kentucky regulations of 401 *KAR* 47:005. The landfill meets the technical standards found in 401 *KAR* 47:080, 401 *KAR* 48:050, and 401 *KAR* 48:070 to 401 *KAR* 48:090, and DOE's remediation contractor has procedures in place to ensure that no wastes are disposed of in the landfill that do not meet the waste acceptance criteria for this facility. This includes soil waste from the NSDD and other areas of PGDP. One aspect of the waste acceptance criteria are the "authorized limits" for waste with *de minimis* levels of radiological contamination to be disposed of in the C-746-U Landfill, as described in *Risk and Performance Evaluation of the C-746-U Landfill at the Paducah Gaseous Diffusion Plant, Paducah Kentucky* (DOE 2003c). The results of this study are summarized as follows:

> These results indicate that the total volume of SWMU 59 excavation can be placed in the landfill and that this placement may adversely impact the balance between the percentage of volume taken and the percentage of contaminant inventory limit taken by ^{237}Np but no other contaminants. It must be cautioned that these results are dependent upon the quality of the data set used to generate the average contaminant concentrations. If these data do not represent areas and volumes within SWMU 59 with higher contaminant concentrations, then the results may be biased low. However, if these data come from sampling biased towards areas of suspected higher contamination, then the results may be biased high. Sampling during waste disposition will be used to address this uncertainty.

Waste characterization activities resulted in all of the excavated soil being disposed of in the C-746-U Landfill. No contaminant levels exceeded threshold criteria that would have caused the waste to be designated as RCRA-hazardous, Toxic Substances Control Act (TSCA)-regulated, or above the authorized limits of the C-746-U Landfill. The amount of waste that might add to the inventory of hazardous constituents or radioisotopes in the landfill is tracked by the DOE Paducah/Portsmouth project health physicist. This is done through documentation prepared for all waste disposed in the C-746-U Landfill, referred to as "landfill packages." These packages are reviewed to determine if the waste they describe may have minute quantities of radiological contamination. If that is the case, then the radiological data is analyzed to determine an estimated inventory of each isotope that will be associated with that landfill package. The estimates based on projected weights and volumes are compared against actual weights and volumes disposed of to ensure that the inventory does not exceed the projections. The inventory allowed for disposal in the C-746-U Landfill is that amount that can be disposed of without exceeding a 1 mrem/yr dose to the maximally exposed individual. This tracking method has ensured that disposal of wastes from the NSDD and other CERCLA-derived wastes do not pose unacceptable risks to human health and the environment.

Figures 12.2 and 12.3 show "before and after" views of the NSDD Sections 1 and 2. The total cost of excavation of Sections 1 and 2, construction of the detention basin, and disposing of approximately 3,200 yd^3 of soil in the C-746-U Landfill was $12.2M according to the *Remedial Action Completion Report for the North-South Diversion Ditch Sections 1 and 2 at the Paducah Gaseous Diffusion Plant, Paducah Kentucky* (DOE 2005d).

A residual risk evaluation was prepared as a result of a recommendation in the 2008 CERCLA Five-Year Review to determine if the remedy for Sections 1 and 2 of the NSDD can be optimized (e.g., risks are at a

level that would support modification of institutional controls and/or cessation of five-year reviews). This evaluation shows that the cleanup goals of the ROD were met.

Figure 12.2. NSDD Sections 1 and 2 Before Remedial Action

Figure 12.3. NSDD Sections 1 and 2 After Remedial Action

12.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Because the excavation exceeded the cleanup criteria set forth in the ROD, long-term maintenance of the clay cover is not required to eliminate exposure pathways. The newly excavated and lined ditch is maintained as part of PGDP's ongoing grounds maintenance program.

The NSDD site inspection was conducted on February 19, 2013, as part of this Five-Year Review. The ditch has been well-maintained; grass was established in the channel, but was not impeding flow. There was no excessive debris over the gabion screens. The aboveground piping was in good condition, the insulation was intact and the metal jacket covering was not rusted or deteriorated; however, several small pieces of the covering were damaged, partially attached or missing. The flow into the surge basin was unimpeded, although there were some cattails in the concrete lining of the basin entry point. There was no standing water in the surge basin. The grass cover is well established and was mowed. There were no visible signs of erosion along the banks of the surge basin. NSDD inspections are ongoing as part of the current remediation contractor's scope.

12.4 TECHNICAL ASSESSMENT

The goals of the remedy were to be implemented by excavating contaminated soil and sediment from the channel of the NSDD, and disposing of it in the C-746-U Landfill, if nonhazardous, or at a permitted facility, if RCRA-hazardous, TSCA-regulated, or greater than authorized limits for the on-site C-746-U Landfill. The waste acceptance criteria at the C-746-U Landfill were met; therefore, all waste soils were disposed of on-site. Upon excavation, a 2-ft clay layer was placed in the NSDD channel to add an extra layer of protection for maintenance workers. The channel was brought to grade with another 2 ft of clean soil and vegetated to prevent erosion. The plugged culverts and detention basin prevent rainfall from inside the plant from flowing beyond the fence and transporting potentially contaminated sediment with it.

The clean-up levels for the excavation were met or exceeded at each measurement section; therefore, maintenance of the clay layer to control exposure is not required (DOE 2005d).

The residual risk evaluation used the decisions/assumptions in the ROD; therefore, the industrial worker, under unrestricted use, was the receptor considered when calculating cleanup levels (LATA Kentucky 2012c). Current exposure assumptions and toxicity data were used to prepare the residual risk evaluation.

The residual risk evaluation quantitatively compared the contamination left in place at the base of the NSDD excavation with outdoor and industrial worker risk-based concentrations as if the contamination were on the surface. The evaluation showed that the residual risk to these receptors falls within EPA risk range (EPA 1999); therefore, LUCs no longer should be considered necessary, provided that the current and expected future use of the area is industrial, as specified in the ROD. The evaluation also recommended continuation of the Five-Year Reviews to ensure that the assumption of industrial land use continues.

12.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed. The excavation as designed met or exceeded the clean-up criteria.

12.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that NSDD Sections 1 and 2 encompass and the land use remains industrial; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the contamination remains valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The residual risk evaluation shows that the goals of the ROD were met and the cleanup levels established still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

12.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

12.4.4 Technical Assessment Summary

The remedial action for Sections 1 and 2 of the NSDD is protective of human health and the environment because contaminated soils and sediments were excavated eliminating the threat of exposure to these media. Plugging culverts and constructing a detention basin prevent rainfall from flowing off-site (i.e., outside the existing security fence) through the ditch and moving contaminated sediment with it.

The maintenance of the clay cover to prevent exposure is not required because the samples collected from the open excavation indicated that the clean-up criteria in the ROD were exceeded along the entire length of the ditch. The clay cover is maintained as part of the overall grounds maintenance program at PGDP. Based on the recommendation of the 2008 Five-Year Review, a residual risk evaluation was performed. The evaluation showed that the residual risk to the outdoor and industrial worker falls within EPA risk range (EPA 1999). Based on the residual risk evaluation, a modification to the LUCIP is recommended that calls for the monitoring of the LUCs to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing the annual verification of administrative controls and annual verification of access to once every five years for NSDD Sections 1 and 2.

12.5 ISSUES

None.

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13. C-746-K LANDFILL

The C-746-K Sanitary Landfill, SWMU 8, is located southwest of the PGDP fenced security area and approximately 200 m (656 ft) southeast of the C-611 Water Treatment Plant. It is situated immediately west of Bayou Creek and north of an unnamed tributary to Bayou Creek. Drainage ditches located along the western and northern edges of the landfill flow to the south into the unnamed tributary and to the east into Bayou Creek, respectively. Figure 13.1 illustrates the location of C-746-K.

Records indicate that PGDP used the landfill between 1951 and 1981 for disposal of fly ash from the plant's coal combustion boilers, uncontaminated combustible plant waste, and potential radiologically contaminated plant waste. The fly ash was believed to have been disposed of in trenches excavated 5 to 10 ft bgs. During operations, trenches were cut in the fly ash and used for burning trash. This practice ceased in 1967, after which waste was buried without burning. The waste, consisting mostly of office and kitchen trash and some construction debris, was placed in trenches excavated within the fly ash and covered, when necessary, with additional fly ash or soil fill. In addition to these materials, sludge from the C-615 Sewage Treatment Plant may have been buried at the unit, as it reportedly was used as fill material. Soil boring information indicates that up to 28 ft of fly ash and trash was placed in the landfill. The landfill was closed in 1982 and covered with a 6- to 12-inch clay cap and an 18-inch vegetative cover.

On January 30, 1992, PGDP personnel discovered leachate in a ditch on the southwest side of the landfill. DOE conducted sampling at five leachate seep locations around the landfill. VOCs (TCE; 1,1-DCE; 1,1-dichloroethane; and *trans*-1,2-DCE) and metals (aluminum, iron, manganese, and zinc) were detected above background levels in the leachate samples. The leachate was acidic and the particulate matter in the leachate generally was orange to yellow in color. The precipitation of dissolved metals from the leachate was thought to be causing the orange to yellow staining observed at various points along the creek banks. The condition was deemed to be in noncompliance with the water quality provisions of 401 *KAR* 5:031, which prohibit discharges that produce "objectionable color" into waters of the Commonwealth of Kentucky. On September 15, 1992, the Kentucky Division of Water (KDOW) issued a Notice of Violation to DOE for "unpermitted seepage areas from the C-746-K Sanitary Landfill into waters of the Commonwealth."

As a result of the Notice of Violation, DOE, with the approval of the EPA and KDEP, undertook an interim corrective action to address the seeps. To prevent any further release of solids to the unnamed tributary, DOE installed a sandbag dam with a liner in the drainage ditch southwest of the landfill. During the interim action, subsidence of the landfill cap was repaired and recontoured to promote surface water runoff. The actions were completed in October 1992 and have been effective in reducing seepage into the creeks. In addition, a surface water monitoring program was initiated at the landfill to monitor contaminant levels in the leachate and adjacent creeks.

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the C-746-K Landfill is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project was not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

Figure 13.1. Location of C-746-K Landfill

13.1 REMEDY SELECTION

The ROD for the C-746-K Landfill was signed by DOE on February 20, 1998, and by EPA on August 10, 1998 (DOE 1998b). KDEP concurred with the selected remedy June 24, 1998, as documented in the *Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D3 (DOE 1998b). The RAOs for this unit are as follows:

- Control the release of COCs from the unit,
- Limit direct contact by humans, and
- Reduce overall risks to ecological receptors.

13.2 REMEDY IMPLEMENTATION

The ROD defined and identified the following components of the remedial action for the C-746-K Landfill (DOE 1998b).

- Install warning signs.
- Place riprap.
- Institute a deed notice and restrictions.
- Continue the existing surface water monitoring program.
- Modify the groundwater monitoring program.
- Continue the current landfill cap maintenance program.

Because the ROD for this IRA was signed prior to the effective date of the PGDP MOA and LUCAP, there is no LUCIP for the LUCs at the C-746-K Landfill.

The *Post-Construction Report and Operations and Maintenance Plan for Waste Area Groupings (WAGs) 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, documents the remedial actions taken at the C-746-K Landfill ROD (DOE 1999b). The O&M requirements were then revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c).

The action implemented at the C-746-K Landfill satisfies the RAOs stated by limiting human and animal exposure to contaminated sediments and acidic leachate by placing riprap over the seep locations. Further reduction of human risks was accomplished by posting warning signs and by placing a deed notice and restrictions on the C-746-K Landfill property.

Surface water monitoring at the C-746-K Sanitary Landfill began in February 1992, following the discovery of leachate in adjacent ditches and creek banks. DOE summarized the monitoring data through October 1992 in the *Work Plan for Interim Corrective Measures at the C-746-K Sanitary Landfill* and developed the monitoring program that was used until October 1998 (DOE 1992). Four stations made up the surface water monitoring network. Two stations, 746KTB1 and 746KTB2 (Figure 13.2), located on the adjacent unnamed tributary and Bayou Creek, respectively, provided upstream monitoring. Two other stations close to the C-746-K Sanitary Landfill, 746K3A and 746K-5 (Figure 13.2) provided downstream monitoring on the adjacent unnamed tributary and Bayou Creek, respectively. The analytical suite for the stream monitoring locations included 13 common metals, arsenic, mercury, uranium, VOCs, PCBs, and pH.

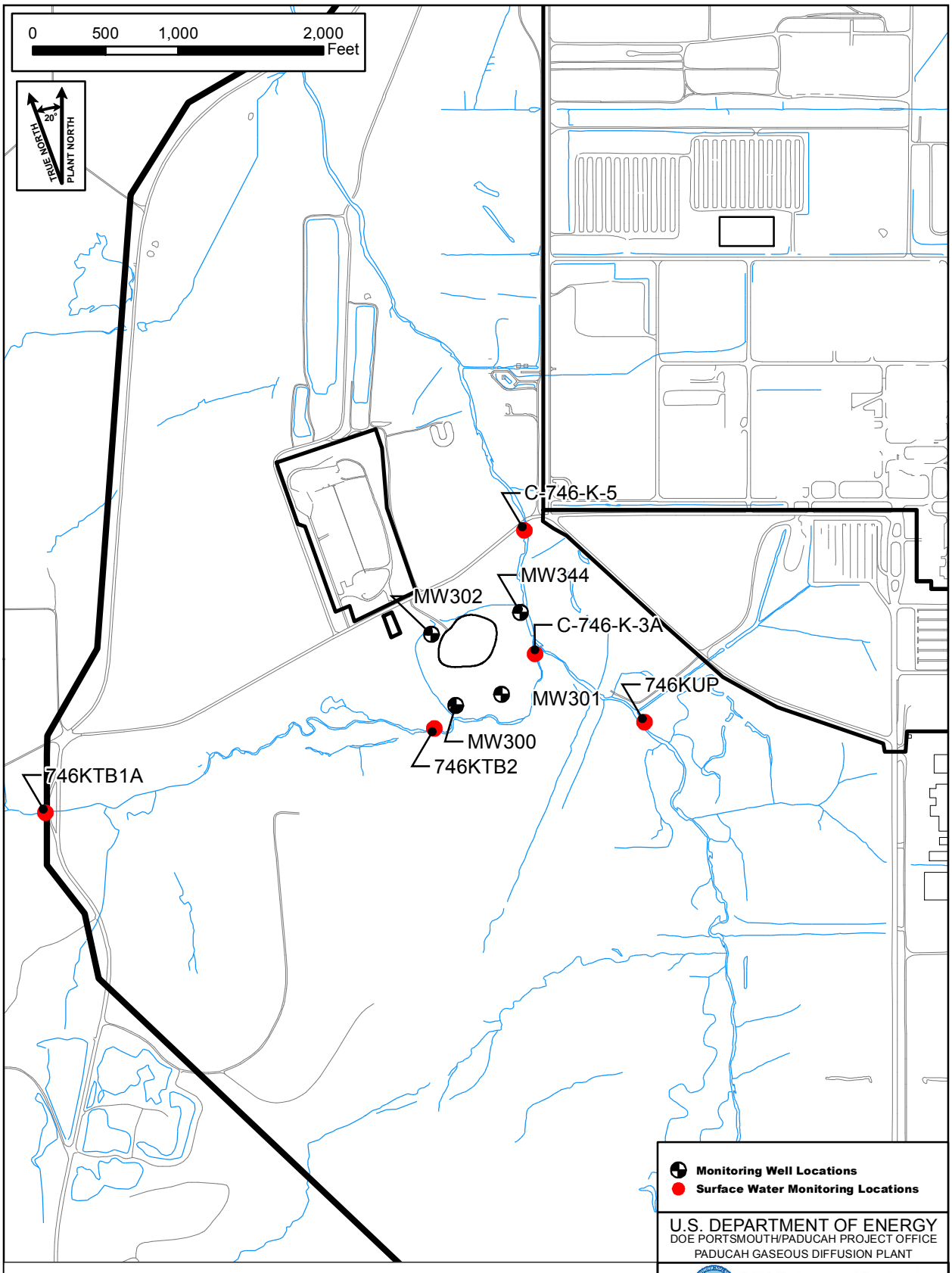

Figure 13.2. Sampling Locations at C-746-K Landfill

Samples were collected monthly through September 1995 and quarterly thereafter. DOE presented the surface water monitoring results in the FFA Semiannual Progress Report to KDWM and EPA each April and October. In summary, the data demonstrated that water quality at monitoring station 746K3A was impacted by the leachate from the C-746-K Sanitary Landfill, while monitoring station 746K-5 appeared to be unaffected. The leachate from the landfill usually contained high levels of dissolved metals, low-levels of dissolved VOCs, and a low pH (2.3 to 3.3 standard pH units).

As stipulated in the ROD, the surface water monitoring requirements for C-746-K were supplanted by a Watershed Monitoring Plan (initially approved October 14, 1998, revised on September 29, 2006, and revised again on February 1, 2010) that was required by the renewed KPDES Permit with effective date of December 1, 2009 for PGDP. The 2009 KPDES permit allowed for the cessation of the aquatic organism sampling because the creeks had been sampled to the point that further sampling could result in a deleterious effect on the aquatic community. The 2009 KPDES Permit also requires only that surface water be sampled quarterly for PCBs and TCE in Bayou Creek. After additional evaluations of the plan and historical data sets, the metals analysis and aquatic organism sampling was removed from the plan in a revised Watershed Monitoring Plan, which was submitted to KDOW on September 27, 2011. Water was last sampled for chemical analysis at the upstream monitoring station on Bayou Creek and the downstream monitoring station on the unnamed tributary to Bayou Creek in 2005 and 2003, respectively. The Watershed Monitoring Plan (1998) included three other interim surface water monitoring stations to assess the C-746-K area. Surface water was last collected for chemical analyses from these stations in 1999.

The remedy identified in the C-746-K Landfill ROD included the placement of riprap on visible leachate seep locations to prevent direct exposure. The action included covering three leachate seep sites and stabilizing the bank of Bayou Creek on the east side of the C-746-K Landfill. Before the leachate seeps were covered, the site was cleared of existing vegetation and a geotextile fabric layer was placed under a layer of riprap. Three leachate seep sites were covered to minimize the potential for human and animal exposure. Construction work for this component of the action began August 5, 1997, and was completed August 12, 1997.

DOE installed warning signs in November 1997 at each of the leachate seep areas and around the landfill. The signs notify the public of the risk associated with the areas. A sign was placed at the entrance of the C-746-K Sanitary Landfill in February 1998. These signs are inspected on a routine basis and are replaced as necessary.

As specified in the ROD and with the approval of KDWM, two MWs (MW184 and MW303) were abandoned. One new well (MW344) was installed to replace MW303 at the C-746-K Sanitary Landfill in March 1998. The intent of the new well was to detect any contamination that could be migrating from the landfill and traveling along the top of the Porters Creek Clay and into the RGA.

A deed notice and a restriction were placed in the chain of title to the deed of the property to inform potential buyers and/or users of the potential risks to human health and the environment posed by the leachate seeps. The notice and restriction were filed August 24, 1998, with the McCracken County Court Clerk.

13.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The C-746-K Sanitary Landfill and its immediate surroundings were inspected on February 4, 2013, to determine if the required remedial actions for the C-746-K Landfill ROD are being met (DOE 1998b).

A sign posted at the entrance to the landfill area clearly identifies the potential human health risks posed by the leachate seeps and contaminated sediments present in the creeks and drainage ditches around the landfill. Additional warning signs are posted at periodic intervals along the west bank of Bayou Creek to the east of C-746-K Landfill and along the north bank of the unnamed tributary to the south of C-746-K Landfill. The signs are in good condition and clearly legible. Additionally, the C-746-K Landfill falls within the boundaries of an extended security buffer zone around PGDP that was established by DOE immediately following September 11, 2001. This buffer zone severely restricts access to the area by the general public.

Riprap that was placed along the west bank of Bayou Creek for erosion protection and to cover apparent seep sites is in place. Riprap also has been placed at one apparent seep area along the unnamed tributary on the south side of the landfill and the area drainage ditch along the west side. These areas also are in good condition.

The covered and capped area of the landfill is in good condition with a well-established grass cover that appears to drain well. There are no indications that water stands on the cap or side slopes. There were no signs of erosion on the landfill cap or side slopes. The area is maintained well and is mowed regularly. There are seven passive gas vents on top of the landfill that are in good condition and show no signs of leakage or settlement. The service road around the landfill is maintained and in good condition.

Two locations in the unnamed tributary and Bayou Creek in the vicinity of SWMU 8 are sampled quarterly.

Figure 13.2 shows the four monitoring well locations and the two surface water monitoring locations. The 2011 through the current CY 2013 Environmental Monitoring Plan (EMP) analytical suite for surface water monitoring includes PCBs, TCE, pH, and other field measurements at these two locations. Of note, the shaft of MW301 has buckled so that pump repair/replacement would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. The data from MW300 would represent the worst case scenario for monitoring purposes, which makes the abandonment of MW301 acceptable. Both MW300 and MW301 are Terrace Gravel wells and both are downgradient of the C-746-K Landfill according to the interpreted southeast groundwater flow through the Terrace Gravel. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.

Table 13.1 summarizes relevant data for COCs since the last Five-Year Review. The surface water monitoring requirements at the C-746-K Landfill have been incorporated into the Watershed Monitoring Plan required by the KPDES permit of December 1, 2009. The modification of the Groundwater Monitoring Program in support of the remedy implementation was to generate groundwater data that could be used for future decision-making purposes involving groundwater remediation. Groundwater monitoring continues under the PGDP Groundwater Monitoring Program and is included in the FFA semiannual reports.

The costs associated specifically with maintenance of the C-746-K Landfill are not tracked separately because they are part of the plant-wide, long-term surveillance and maintenance, and environmental monitoring programs.

Table 13.1. Summary of Surface Water Quality Analyses for the C-746-K Landfill COCs–2008 through 2012

		Bayou Creek (surface water)	Unnamed Tributary (surface water)
Analyte	**Unit**	**C-746-K-5 (downstream)**	**746KTB1A (upstream)**
Aluminum [a]	mg/L	ND-2.67	ND-1.04
Iron [a]	mg/L	0.22-1.82	ND-0.805
Manganese [a]	mg/L	0.024-0.121	0.0245-0.0425
Zinc [a]	mg/L	ND	ND
TCE [b]	µg/L	ND	ND

[a] For years 2008–2010
[b] For year 2008–2012
ND = nondetect

13.4 TECHNICAL ASSESSMENT

The overall objectives of this project were to control the release of COCs from the unit, reducing the ecological risks, and limiting human contact. The risk assessment for the C-746-K Landfill determined that the unit posed unacceptable risk to industrial workers and animals via direct contact with leachate and contaminated sediments.

The current remedy for the C-746-K area includes institutional controls (LUCs and engineering barriers to prevent exposure), along with groundwater monitoring for potential migration of contaminants off-site. The concentrations of metals detected in surface water that are listed in Table 13.1 were compared to the surface water preliminary remediation goals (PRGs) (i.e., cleanup goals) generated for the PGDP human health Risk Methods Document (DOE 2011d). For metals, the lowest PRGs associated with surface water are for the child swimming scenario. The PRGs for that scenario are 82.8 mg/L for aluminum, 58 mg/L for iron, 0.529 mg/L for manganese, and 26 mg/L for zinc, and are current for exposure assumptions and toxicity data. All detections in Table 13.1 are below the corresponding lowest PRG for surface water. The results in Table 13.1 were also compared to the Kentucky surface water standards in 401 *KAR* 10:031. The chronic warm water aquatic habitat criteria are 1 mg/L for iron and a function of hardness for zinc; there are no criteria for aluminum and manganese (KY 2013). Results from surface water are below these Kentucky standards, with the exception of the maximum result for iron downstream. The 2010 PGDP ecological risk methods document provides surface water screening levels for aluminum, iron, manganese, and zinc as 0.087 mg/L, 1 mg/L, 0.12 mg/L, and 0.05971 mg/L, respectively (DOE 2010d). Maximum results exceed ecological surface water screening values for aluminum both upstream and downstream and iron and manganese downstream. Results are shown graphically in Figures 13.3–13.5 for iron, aluminum, and manganese.

These comparisons indicate that the remedy continues to be protective of human health and the environment due to restricted direct exposure and because surface water contaminants are near or below applicable surface water standards and screening levels.

13.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as intended. The riprap, landfill cap, and signs are in place and in good condition. No problems were noted with the systems operation or maintenance.

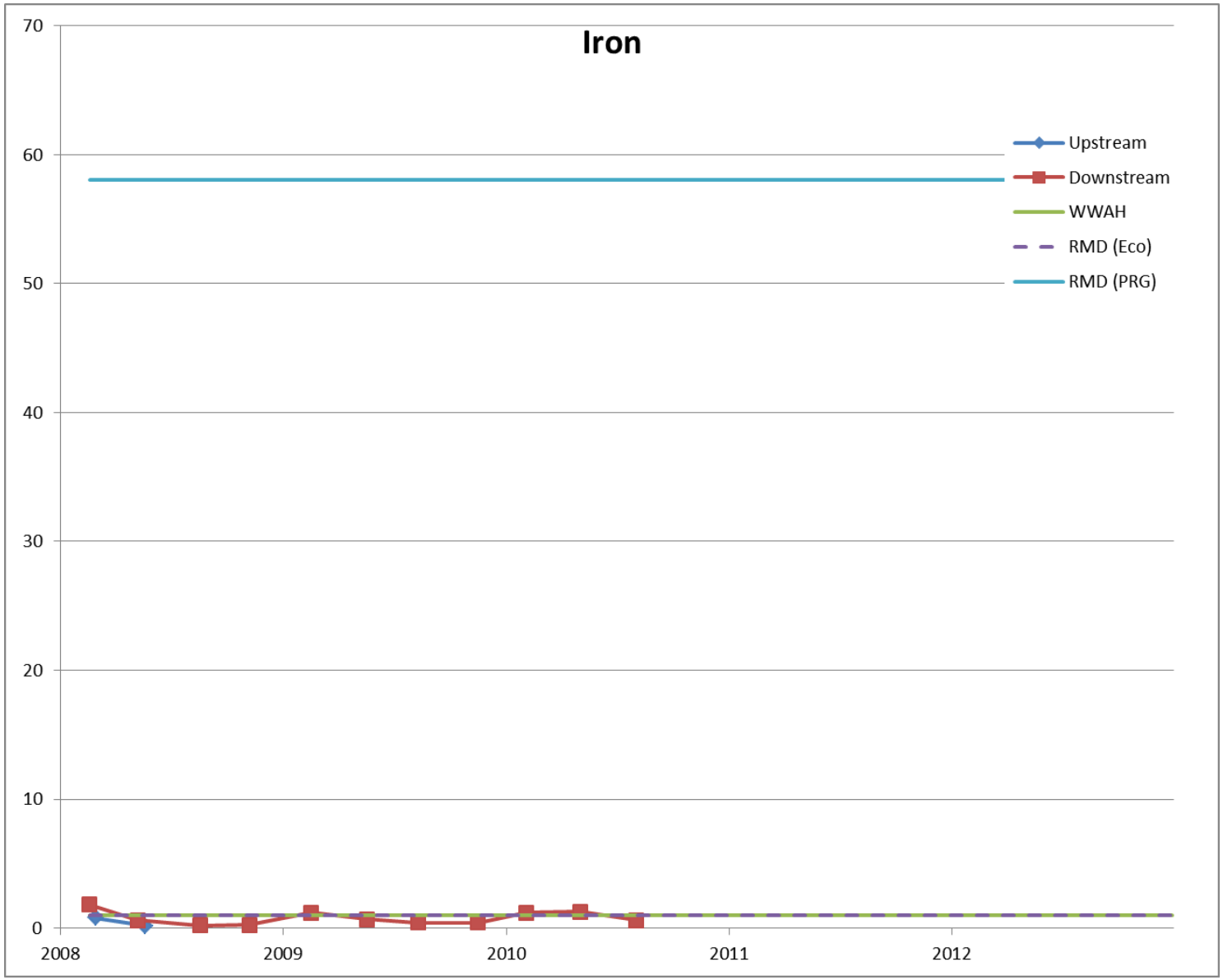

Figure 13.3. Surface Water Results for Iron at C-746-K Landfill

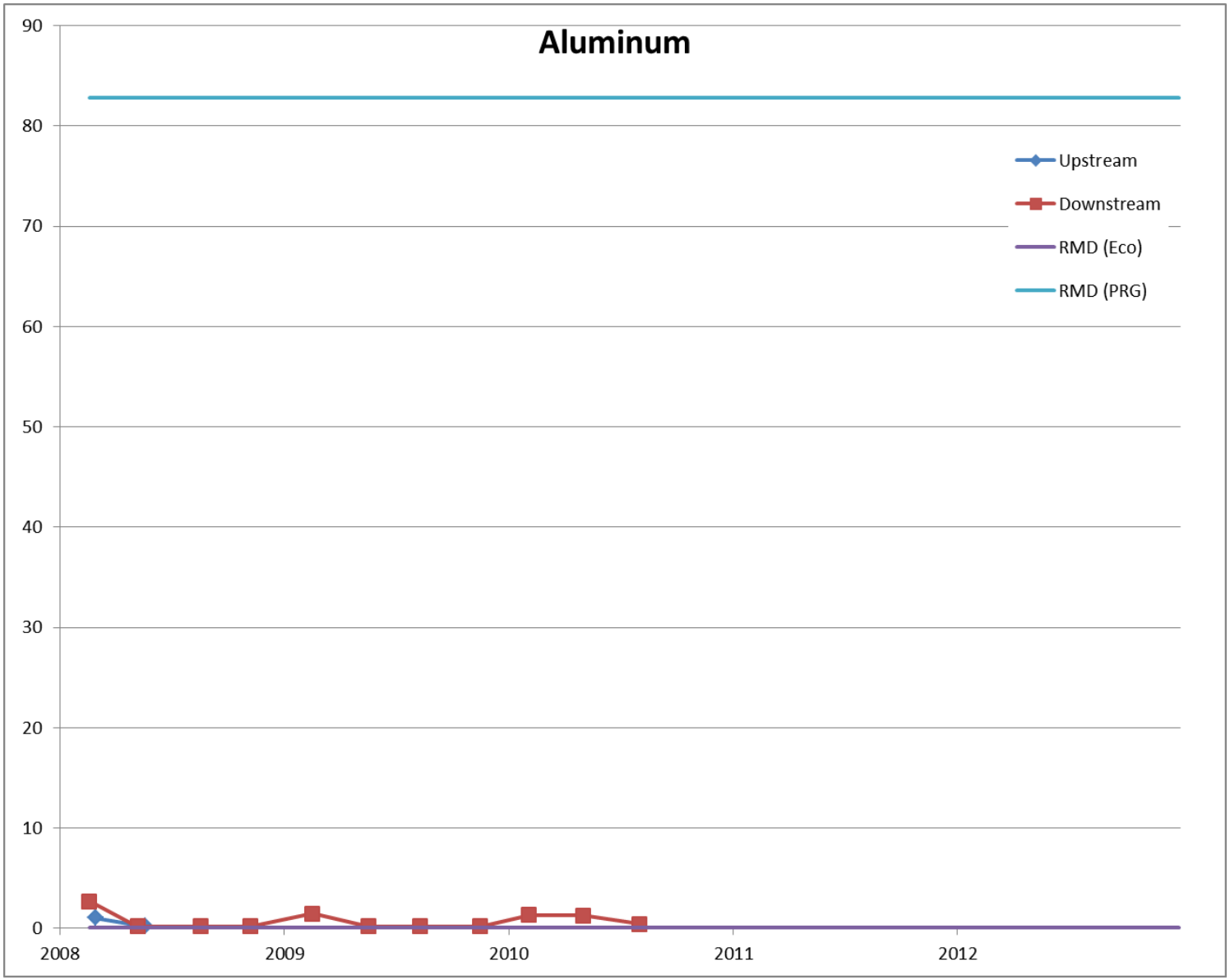

Figure 13.4 Surface Water Results for Aluminum at C-746-K Landfill

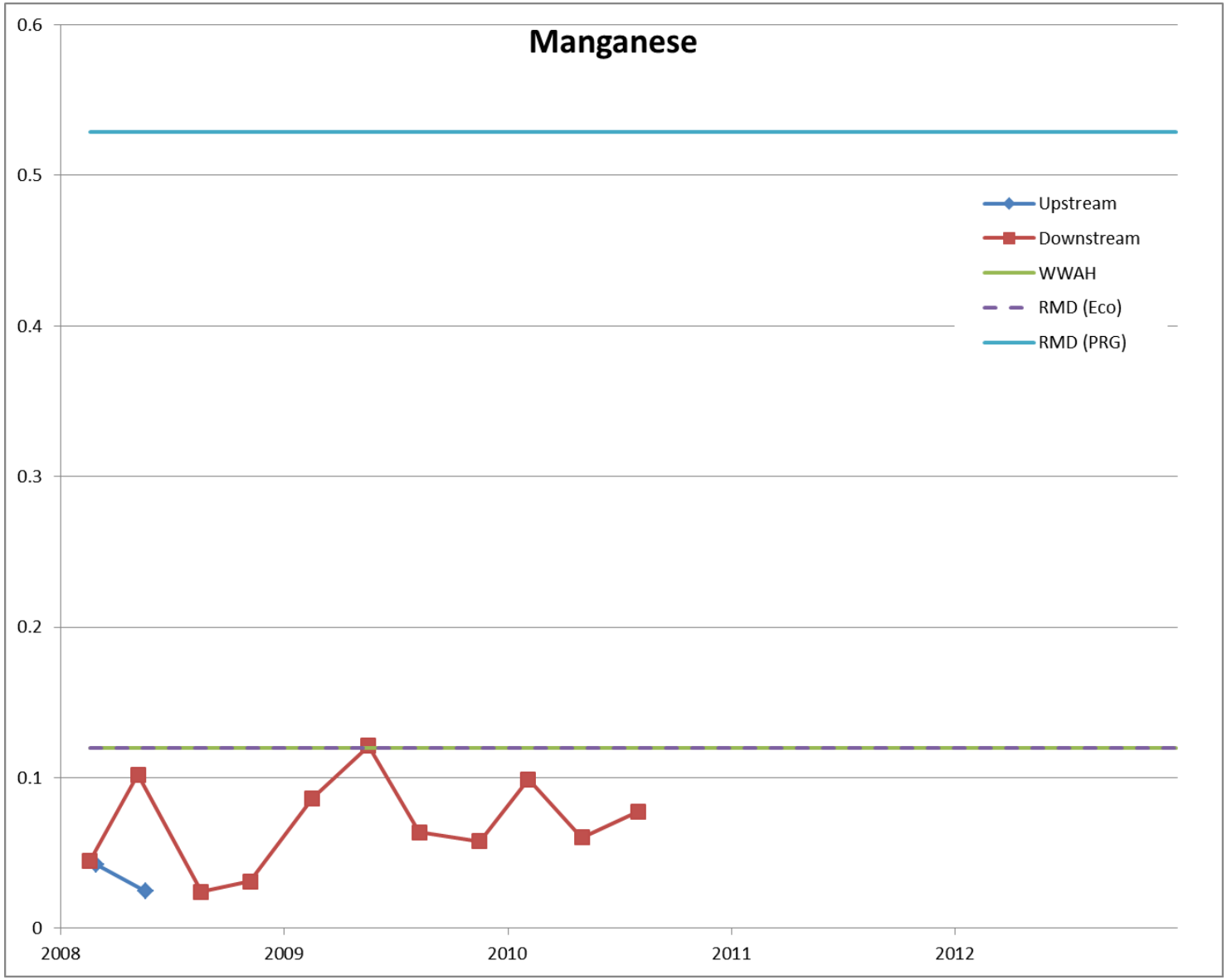

Figure 13.5. Surface Water Results for Manganese at C-746-K Landfill

13.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that SWMU 8 encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the waste, sediments and leachate remains valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal of the waste and impacted soils.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

13.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

13.4.4 Technical Assessment Summary

The remedy is functioning as intended by the ROD. ARARs for leachate discharges and radionuclide exposures cited in the ROD have been met. During the 2008- 2012 review period, the remedial action at the C-746-K Landfill continued to reduce the potential for human exposure by notifying persons of the potential hazards in the area from contaminants seeping from the landfill (DOE 1998b). The potential for direct human contact also is reduced by the placement of riprap along the seeps and by deed notice and restrictions recorded for the C-746-K Landfill, which restrict use of the property.

13.5 ISSUES

None.

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14. FIRE TRAINING AREA

The Fire Training Area, SWMU 100, is located in the southwest corner of PGDP. At the time of the investigation of this area, it consisted of one large rectangular surface burn area, two circular burn pan areas, one circular electric pump area, an elevated and bermed fuel tank area, and two square burn area depressions. The burn areas were unlined and were not bermed. The Fire Training Area has been used since 1982 for staging fire training exercises involving waste oils, fuels, and other combustible liquids. Combustible liquids were not burned in the unlined areas after 1987. Fire training exercises continue to be conducted in the vicinity, but in order to prevent any negative impacts to the environment, no burning is conducted in unlined areas, and flammable liquids are no longer used. Figure 14.1 illustrates the location of the Fire Training Area.

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the Fire Training Area is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the area to unrestricted use.

14.1 REMEDY SELECTION

The selected remedy, which depends on the area remaining industrial, for the Fire Training Area, SWMU 100, was no further action (outside of maintaining institutional controls) as documented in the *Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D3 (DOE 1998b).

14.2 REMEDY IMPLEMENTATION

None.

14.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

A site inspection of the Fire Training Area was conducted on February 4, 2013. Although it is apparent that the concrete area is used for fire fighters' training, the ground surface features described in the first paragraph of this chapter no longer are apparent. Grass was established in the area and appears to be maintained. There were no areas of erosion.

14.4 TECHNICAL ASSESSMENT

There have been no detrimental changes to the Fire Training Area. The "no further action" decision remains protective. Its current use as a fire-fighters training area shows no apparent harm to the environment. No further action is necessary to protect PGDP workers at the Fire Training Area who are not associated with the fire protection department.

14.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy, specifically the current land use, is functioning as intended.

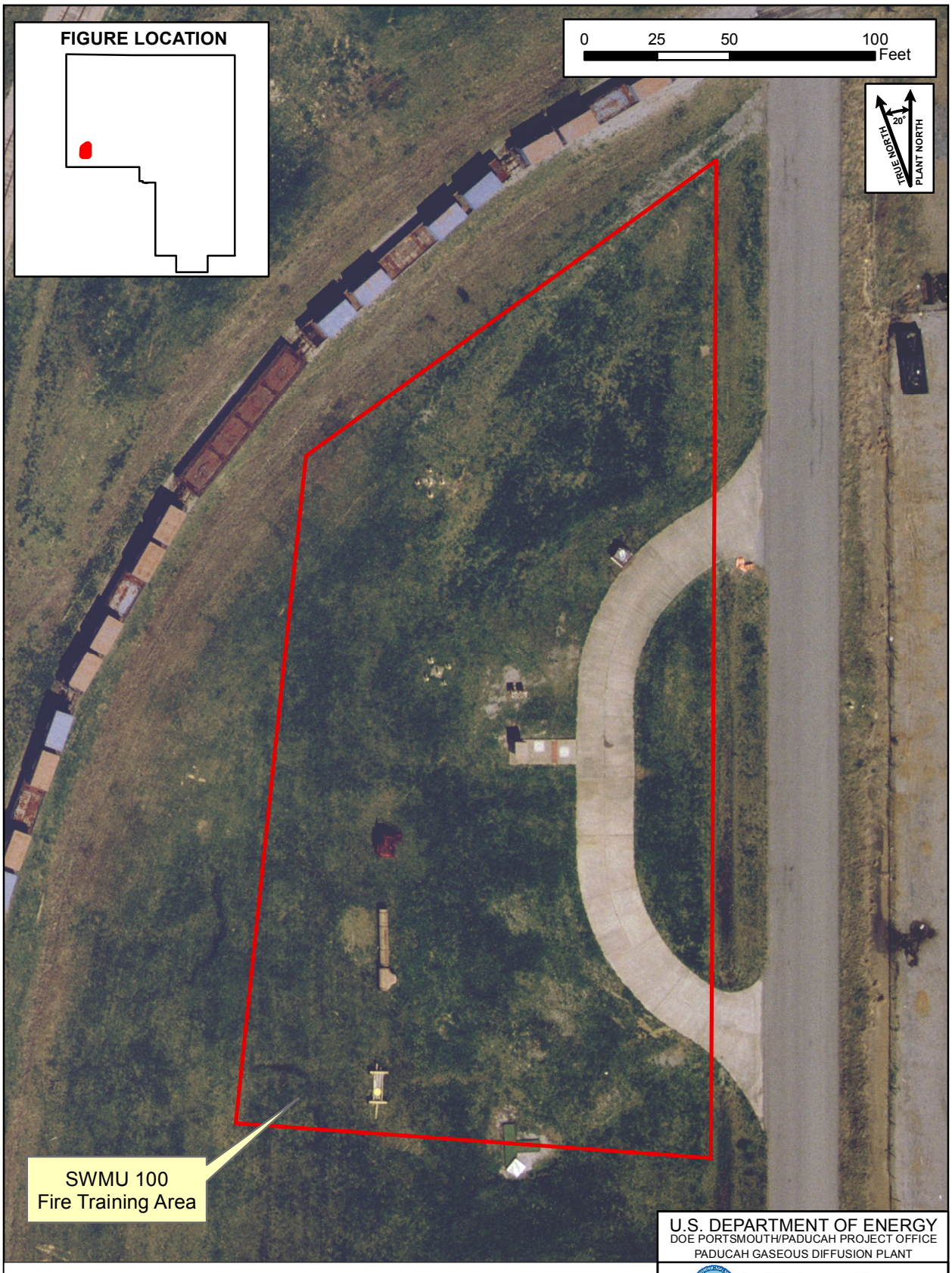

Figure 14.1. Location of Fire Training Area

14.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. DOE remains in control of the property that SWMU 100 encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD remain valid. For SWMU 100, the WAGs 1 and 7 RI report states that the primary pathway contributing to both the total hazard index (HI) and the total excess lifetime cancer risk (ELCR) is dermal contact with sediment (DOE 1996c).

Updates have been made to dermal toxicity to correct the overly conservative estimation of risk that used dermal absorption factors that exceed oral absorption values (DOE 2013b). These updates do not adversely impact the remedy selected. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels, RAOs, or ARARs were established in the ROD because the selected remedy was no further action (outside of maintaining institutional controls).

14.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

14.5 ISSUES

None.

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15. SURFACE WATER INTERIM CORRECTIVE MEASURES

Initial site investigations at PGDP indicated that various units were contributing to off-site surface water contamination. The *Results of the Site Investigation, Phase I* (CH2M HILL 1991) give a preliminary description of the nature and extent of contamination and risk associated with the off-site contamination. Phase II [*Results of the Site Investigation, Phase II* (CH2M HILL 1992)] of the investigation further assessed the nature, extent, and risk of off-site contamination and identified and characterized those SWMUs possibly contributing to off-site contamination. Phase II also included the draft PHEA. The results of the site investigation identified 21 SWMUs which were believed to be contributing to off-site contamination. Of these, nine were identified as contributing primarily to groundwater contamination, nine were identified as contributing primarily to soils and sediment contamination, and three were found to be contributing to both. The contaminants included PCBs, radionuclides (primarily U-238) and metals.

Of particular concern at the time were the surface water sediment and soils at KPDES outfalls west, north, and east of the facility. These included KPDES Outfalls 001, 002, 003, 010, 011, and 012. Surface-water patterns at the PGDP at the time that the action took place have changed significantly. The concerns at the time are noted below, along with information on whether that surface water drainage has changed.

The 2008 review had the following protectiveness statement:

> The remedy for the surface water interim corrective measures currently protects human health and the environment by institutional controls; however, additional actions under the SWOU need to be evaluated for long-term protection.

15.1 REMEDY SELECTION

In July 1993, DOE implemented an interim measure to reduce potential for exposure to contamination in surface water and sediment in the vicinity of PGDP. The proposed action was documented in the *Interim Corrective Measure Workplan for Institutional Control of Offsite Contamination in Surface Water Outfalls, Creeks, and Lagoons* (DOE 1992). The actions chosen were to install fencing and posting signs to warn people in the area of the dangers posed by direct contact with the water and/or sediments.

The objectives of the Surface Water ICMs chosen actions were the following:

- To restrict access by the general public and site personnel to contaminated areas, thus reducing direct exposure and the potential for inadvertent transport of contaminants;
- To restrict access by the general public to contaminated areas for recreational uses;
- To identify contamination areas to the public and site personnel; and
- To monitor water and sediments as part of the KPDES program.

No ARARs were identified for this action in the decision document.

A modification to the work plan, as documented in the approved *Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water*, deferred activities on Bayou Creek until additional characterization was performed (DOE 1993c).

15.2 REMEDY IMPLEMENTATION

To achieve the objectives listed, signs and fencing were required for the locations indicated on Figure 15.1. DOE installed fencing and posted warning signs in areas of contamination at eight location areas to prevent direct human contact with contaminated sediments. Each location area was posted with a varying number of signs dependent upon the area of contamination. These signs are referred to as the Surface Water ICM signs. The *Operations and Maintenance Plan for Institutional Control of Off-site Contamination in Surface Water at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (MMES 1993) was the original documentation for the O&M activities for the Surface Water ICM.

The language originally proposed was revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c). The signs read as follows:

> This waterway is contaminated. Use of this waterway for drinking, fishing, swimming, or other forms of recreation may expose you to unnecessary health risks. Do not eat fish caught in this body of water. Do not cross posted boundaries. Cross only in designated areas. For information, call (270) 441-5023.

Water and sediments were monitored as part of the KPDES program. All KPDES program requirements are specified in the EMP, which is updated on an annual basis.

15.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The O&M requirements were revised in the document *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c). Signs are inspected monthly and repaired or replaced, as needed.

Although the sampling and assessment of surface water and sediment data is part of the PGDP environmental monitoring program it is not part of the Surface Water ICM. The results of the environmental monitoring program are reported in the Annual Site Environmental Report.

The locations of the signs and fences were inspected on February 20, 2013. The ICM signs were in good condition. Also, at all locations the Surface Water ICM signs were posted along with "KEEP OUT," "no trespassing" and radiological warning signs. The fences at all locations were in place, with the exception of some of the fencing along the NSDD Section 3 which was subject to the SWOU Removal Action discussed in Chapter 16. A recommendation has been made for the fencing to remain down based on the residual risk evaluation, which was prepared as part of the SWOU On-Site Removal Action Report, and is discussed later in this Chapter and Chapter 16 (DOE 2011a).

The environmental responses for the NSDD, Scrap Metal Disposition Project, and SWOU On-site have impacted the Surface Water ICM. These actions included construction projects inside PGDP to prevent transport of contaminated sediment off-site (i.e., outside the existing security fence and off DOE property) and in 2010, the Surface Water On-site Sediment Removal (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. After September 11, 2001, PGDP instituted a security buffer zone, which prevents members of the public from accessing the locations of some signs (See Figure 15.1 for current areas closed to public access). Considering the limited access that has been imposed at some of the sign locations and the environmental response actions that have taken place, the possibility of long-term exposure of humans to contaminated sediment and surface water is much less than it was when the signs were put in place.

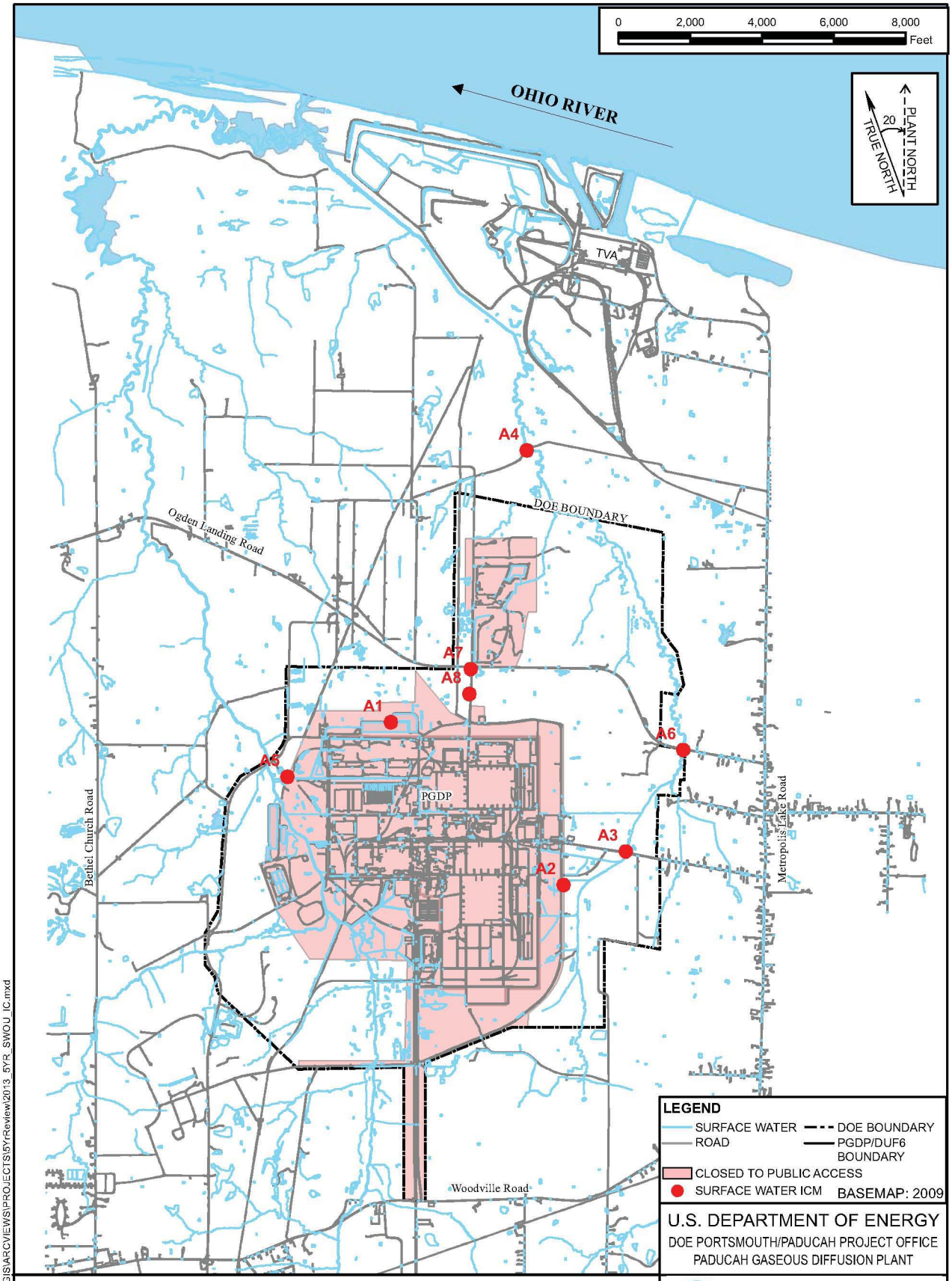

Figure 15.1. Location of Signs and Fencing Installed for the Surface Water ICM

Following the erection of the fencing and signs in support of the Surface Water ICM Work Plan, another sign program was implemented in 2008. It was implemented through the Government Performance and Results Act (GPRA). The GPRA holds federal agencies accountable for using resources wisely and achieving program results. EPA, under direction from Congress, established two environmental indicators (EIs): (1) groundwater contaminant migration under control and (2) human exposure under control. KDEP had the responsibility for making this determination. The three determination choices were as follows: (1) Yes, contamination under control; (2) No, contamination not under control; or (3) Insufficient information.

In order to help achieve a "Yes" with regard to the GPRA milestone of having Human Health Exposures Under Control, DOE placed EI signs in nine locations along the Bayou and Little Bayou Creeks, as well as in off-site (i.e., outside the existing security fence) portions of Section 5 of the NSDD in the spring of 2008. The placement of these EI signs, along with flowcharts that demonstrated decision making processes that would reduce uncertainty for nonworker exposure associated with PGDP, aided KDEP in achieving a "Yes." Although these signs were not erected through an FFA party agreement, these EI signs were placed in areas that are managed by FFA decision documents (i.e., *ICM Work Plan*); therefore, after the EI signs were erected, the site was managing signs in the surface water areas using two sign programs: EI signs and the Surface Water ICM signs.

The issue of the management of two sign programs was captured in the following CERCLA Five-Year Review report. The *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/0117&D2, (DOE 2009a) evaluated the SWOU and identified the following issue: "Signs were erected under the scope of another project. Although the message content between the signs does not conflict with each other, an evaluation of the sign program is needed." This issue denotes that the EI signs were located in the same areas where the Surface Water ICM signs were located. Though the intent of the signs is the same, subtle differences existed in the wording between the two types of signs, and contact information was inconsistent (i.e., phone numbers). The 2008 Five-Year Review document provided the following recommended action for the issue: "Evaluate whether interim corrective measures signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs."

An evaluation of both sign programs was finalized in 2010, and a recommendation was made to replace the Surface Water ICM signs with the more current language of the EI signs. This action will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. Each sign will be assigned a unique number thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site Removal Action Report (RAR) residual risk evaluation (DOE 2011a). The former fencing in areas A7 and A8 add no real value since the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

Specifically, the evaluation proposes that, where the signs are co-located, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. Also recommended is that remaining fencing located at areas A7 and A8 be removed, and signs located at A1 will be removed (see Figure 15.1).

Table 15.1. ICM/EI Sign Evaluation Recommendations

ICM Area Number	Description of Area	Is Fencing Present?	Posting Recommendation
A1	C-616 Lagoons	**Yes**	**Remove** ICM signs but leave fencing—area is not readily accessible by the public
A2	KPDES Outfall 011 and Dyke Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A3	Little Bayou Creek and McCaw Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A4	Little Bayou Creek and Anderson Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A5	KPDES Outfall 001 and New Water Line Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A6	Little Bayou Creek and Ogden Landing Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A7	NSDD and Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs
A8	NSDD-PGDP to Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs

15.4 TECHNICAL ASSESSMENT

Outfalls 002, 010, 011, 012, 013, 019, and 020 drain the eastern boundary of PGDP and flow eastward toward Little Bayou Creek. The areas included in the drainage networks for these outfalls are comprised mostly of USEC process equipment and the on-site landfill. In 2010, the Surface Water On-site Sediment Removal (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. There have been no construction projects since the last Five-Year Review that would affect drainage in these drainage networks.

Outfall 001 drains the units in the northwest corner of the PGDP security fenced area. The C-613 Sedimentation Basin was constructed as part of the Scrap Metal Disposition Project to capture contaminated sediment that was transported off-site (i.e., outside the existing security fence) while moving heavy equipment inside the C-746-P, C-746-E, and C-746-C scrap yards during sorting, segregating, downsizing, and packaging activities, and during ongoing and upcoming environmental response actions.

The surface water flowing north of the facility was drained primarily by KPDES Outfall 003, which drained some overflow during storm events from the NSDD. Actions taken by two projects discussed in other chapters of this report, NSDD Source Control (Chapter 11) and NSDD Sections 1 and 2 (Chapter 12), have eliminated this outfall. The stormwater that drained through NSDD to Outfall 003 when the Surface Water ICM was implemented was diverted to the C-616 treatment facility and then is discharged through Outfall 001.

15.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. Potential users of creeks, ponds, or streams outside the PGDP security fence are warned that contact with contaminated water and sediment may pose potential dangers. Sediments and water continue to be sampled through the EMP and results are made available through the Annual Site Environmental Report.

A recommendation to optimize the sign program has been made. Based on the evaluation, removing of all Surface Water ICM signs and increasing the overall number of EI signs will result in only one sign program. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site RAR residual risk evaluation (DOE 2011a). The previous fencing in areas A7 and A8 adds no real value because the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

15.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. Exposure pathways included direct radiation, ingestion of fish, dermal absorption, ingestion of sediment and water, although specific exposure parameters were not described in the decision document and still are valid. This interim action did not remove the source of contamination nor did it prevent biota exposed to the surface water and sediment from becoming contaminated.

Toxicity information or specific cleanup criteria were not discussed in the work plan because the selected remedy did not include excavation and removal of impacted soils/sediments. There have been no new contaminants or new understanding of geologic conditions identified.

There were no ARARs identified in the work plan (DOE 1992).

The RAOs used at the time of remedy selection still are valid.

15.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No. As previously stated, some sign locations are now in a restricted access security buffer zone due to responses after September 11, 2001, which prevents most human contact with contaminants in the streams. The access changes have led to greater protectiveness for these areas.

A residual risk evaluation was prepared as part of the SWOU On-Site RAR (DOE 2011a). Analytical data were compared against current industrial worker no action levels at all locations and recreational user no action levels at the NSDD for soil/sediment presented in *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001b). The RAO for the removal action was met, which was to ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range. The calculation of cumulative residual risk and hazard indicates that the cleanup goal to achieve to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 was obtained for the targeted action areas, but did not provide for unlimited use/unrestricted exposure.

No other information has come to light that would call into question the protectiveness of the remedy.

15.4.4 Technical Assessment Summary

This action is meeting the objectives as stated in the decision document. The remedy protects human health and the environment because the fences prevent recreational users from contacting contaminated sediment and water. This action was not intended to restore the area in which it was implemented to unrestricted use.

15.5 ISSUES

None.

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16. SURFACE WATER ON-SITE SEDIMENT REMOVAL

NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas have been identified as SWMUs under the FFA due to the potential for actual or threatened releases of hazardous constituents. The following are the specific SWMUs:

- SWMU 58-Sections 3, 4, and 5 of the NSDD
- SWMU 63-Outfall 008
- SWMU 66-Outfall 010
- SWMU 67-Outfall 011
- SWMU 68-Outfall 015
- SWMU 69-Outfall 001
- SWMU 92-PCB Spill
- SWMU 97-C-601 Diesel Spill

The identified contamination was derived from surface water runoff and wastewater from various plant activities conducted at PGDP facilities and was determined to pose human health risks from direct contact with contaminated sediments greater than the EPA risk range under some scenarios. Figure 16.1 illustrates the location of the SW On-site Sediment Removal action.

Sections 3, 4, and 5 of the NSDD, SWMU 58, are located outside the security fenced area on property owned by DOE. The NSDD originates within the north-central portion of the PGDP and discharges into Little Bayou Creek to the north of the plant.

Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas are located both inside and outside the security fenced area on property owned by DOE. The internal plant ditches that discharge to NSDD and the outfalls were trenched when PGDP was built and became fully operational when the plant was opened in 1951. Water discharged at each outfall is regulated by a KPDES permit, and the water quality is tested regularly at established monitoring stations, in accordance with the conditions of the KPDES permit.

SWMU 92 was designated as a SWMU due to placement of PCB-contaminated soils as fill from a transformer rupture in 1967. SWMU 97 was designated as a SWMU due to a diesel oil spill that occurred on March 9, 1979.

NSDD Sections 3, 4, and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including SWMUs 92 and 97) have been characterized in several investigations. These included the Phase I and Phase II SIs (CH2M HILL 1991; CH2M HILL 1992); various WAG and SWMU remedial investigations, site evaluations, and removal actions; and a 1996 PCB Study by the U.S. Army Corps of Engineers (COE 1996). In 2005, the SI for the SWOU (On-Site) was conducted and focused on the first sequenced response action for on-site portions of the SWOU at PGDP (DOE 2008b). The investigation involved the collection of surface soil and sediment samples from various outfalls and their associated internal ditches and storm sewer discharge water to evaluate areas within the SWOU having the greatest potential for contaminant discharge to creeks surrounding PGDP.

16.1 REMEDY SELECTION

The Surface Water On-site Sediment Removal was performed as a non-time-critical removal action under the Paducah Federal Facility Agreement. CERCLA documents that described the logic for this project and

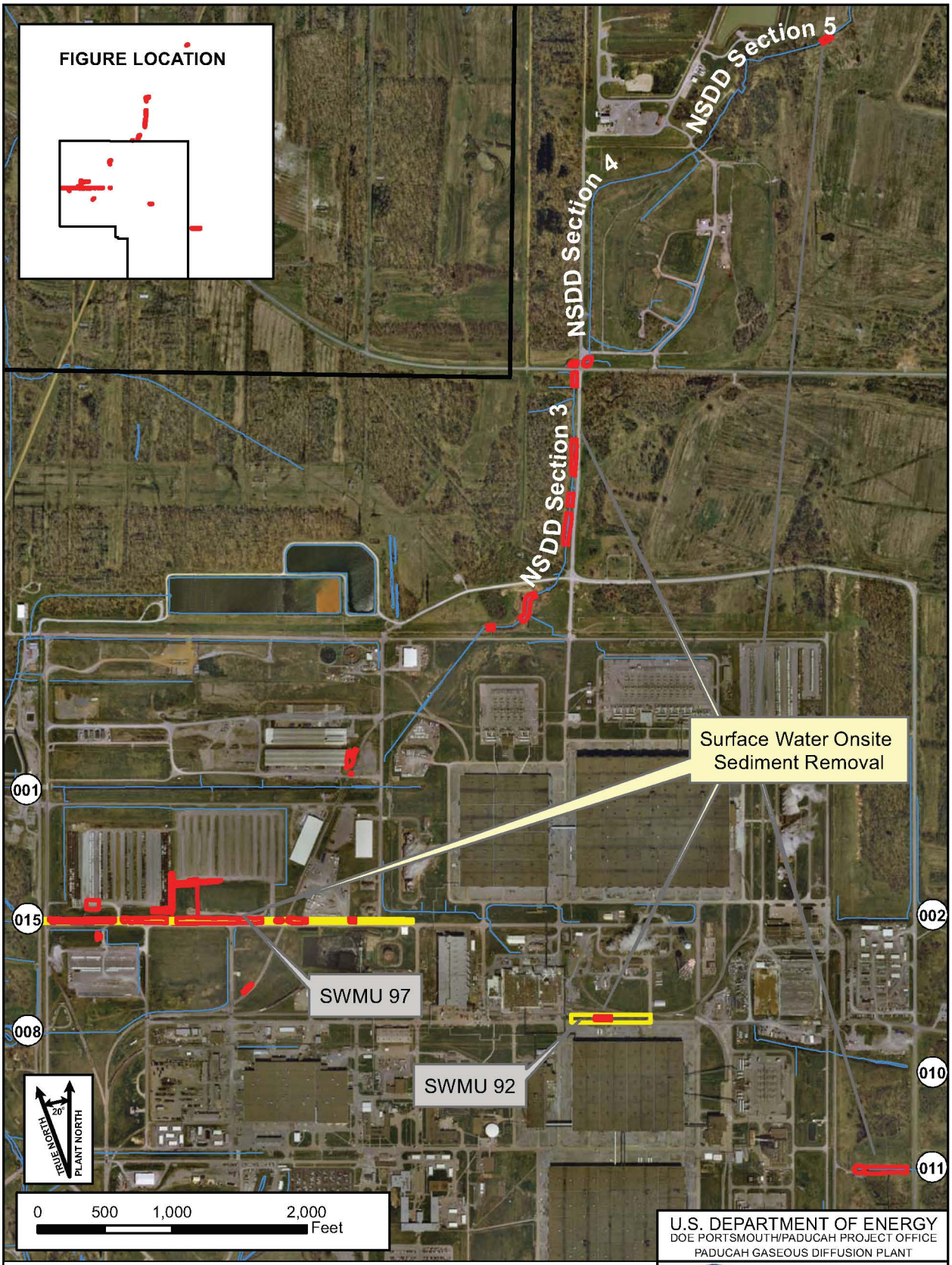

Figure 16.1. Location of Surface Water On-Site Sediment Removal

the basis for its implementation are as follows: *Engineering Evaluation/Cost Analysis for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2008c); *Action Memorandum for Contaminated Sediment Associated with the SWOU (On-Site)* (DOE 2009c); and *Removal Action Work Plan for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0221&D2/R1 (DOE 2009d).

The RAOs were consistent with the overall RAOs for the SWOU and include the following:

- Ensure direct contact risk at the on-site ditches for the current industrial worker falls within the EPA risk range (EPA 1999).

- Ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range (EPA 1999).

16.2 REMEDY IMPLEMENTATION

The action implemented excavation and removal of areas of known contamination (i.e., soil/sediment) associated with the NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including SWMUs 92 and 97).

The action was implemented in November 2009 and completed in September 2010 and consisted of the following components:

- Excavated hot spots to a depth of 2 ft to eliminate the risk of human receptors contacting contaminated sediment. Hot spots under this action were identified using a cumulative ELCR of 1E-05 and a cumulative HI of 1.0.

- Collected samples from the bottom of the hot spot to confirm that the specified cleanup levels were achieved, subsequently meeting the project RAOs.

- Consistent with the results of the risk-based cost-benefit analysis, verification of cleanup to the cumulative ELCR of 1E-05 and a cumulative HI of 1.0 following excavation was based upon comparisons between sampling results and chemical-specific ELCR-based and HI-based cleanup levels. The ELCR target used in deriving the cleanup levels was 5E-06. The HI target used in deriving the cleanup levels was 1.0.

- Methods to validate the achievement of the chemical-specific cleanup levels were implemented similar to the NSDD Sections 1 and 2 remediation.

- Installation of temporary localized engineering controls a small stormwater retention area, silt fencing, and rock check dams during excavation activities. Installation controlled sediment and contaminant migration from the action.

- Restored (i.e., backfill with clean soil, reseeding, etc.) disturbed acreage to prevent erosion, migration and recontamination.

- Characterized, containerized, transported, and disposed of all equipment and contaminated soil/sediment at an appropriate disposal/storage facility.

- Assessed temporary localized engineering controls and discontinued as appropriate.

- Continued inspection and site maintenance during and after excavation and restoration to control erosion, and until the excavated/restored area was stable.

Figures 16.2 through 16.33 show "before and after" views of NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas. The total cost of excavation and disposing of the approximately 10,160 yd^3 of soil in the C-746-U Landfill and 12,517 yd^3 of soil at Energy*Solutions* was $18,312,363, according to the *Removal Action Report for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2011a).

The RAOs were attained through the removal of identified hot spots and verification of cleanup to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0. The cumulative hazard and cancer risk for the EUs are listed in Table 16.1.

Table 16.1. Cumulative ELCR and HI for SWOU EUs

Outfall/NSDD Section	EU	ELCR (Cancer)	HI (Hazard)
INDUSTRIAL WORKER			
Outfall 001	15	4.90E-06	0.1
Outfall 008	11	4.50E-06	0.1
Outfall 010	10	4.30E-06	0.1
Outfall 011	1	3.80E-06	0.3
Outfall 015	2	2.50E-06	0.1
	3	2.20E-06	0.1
	4	1.00E-05	0.2
	7	2.80E-06	0.1
	8	9.20E-06	0.2
Section 3	1	3.90E-06	0.2
	2	5.10E-06	0.1
	3	7.30E-06	0.2
Section 5	8	5.80E-06	0.4
RECREATIONAL USER			
Section 3	1	5.40E-06	< 0.1
	2	5.30E-06	< 0.1
	3	5.80E-06	< 0.1
Section 5	8	1.20E-05	< 0.1

A residual risk evaluation was prepared as part of the RAR. Analytical data were compared against current industrial worker no action levels at all locations and recreational user no action levels at the NSDD for soil/sediment presented in *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001b). The calculation of cumulative residual risk and hazard indicates that the removal goal of cleanup to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 was achieved.

This non-time-critical removal action was considered complete after the RAOs had been verified as achieved; verification or characterization sampling was performed; engineering and temporary access controls were evaluated and discontinued, as appropriate; the site was restored and determined stable; and treatment, storage, or disposal of contaminated media and waste was completed.

16.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

There is no O&M for this remedy.

A site inspection was conducted on February 4, 2013. All areas were grass covered or riprap covered and in good condition. Section 3 of the NSDD did show some signs of erosion on the steep slopes.

16.4 TECHNICAL ASSESSMENT

The remedial action for NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including SWMUs 92 and 97) are protective of human health and the environment because the threat of exposure from direct contact was eliminated by removing the known sources of contamination.

16.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed. The excavation as designed met or exceeded the clean-up criteria. The RAOs for this removal action were achieved by reducing the risk to current industrial workers and recreational users from direct contact by removing known sources of contamination.

16.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

The land use has not changed for each area addressed by the removal action and remains either industrial or recreational; therefore, the exposure assumptions used in the AM remain valid.

There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected as demonstrated by the results of the residual risk evaluation. There have been no new contaminants or new understanding of geologic conditions identified.

There are no changes in standards identified as ARARs in the AM that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the AM that impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

16.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

16.5 ISSUES

None.

Figure 16.2. Outfall 001 11-12-09 (Before)

Figure 16.3. Outfall 001 11-12-09 (Before)

Figure 16.4. Outfall 001 07-22-10 (After)

Figure 16.5. Outfall 001 07-22-10 (After)

Figure 16.6. Outfall 010 11-12-09 (Before)

Figure 16.7. Outfall 010 07-12-10 (After)

Figure 16.8. Outfall 011 11-12-09 (Before)

Figure 16.9. Outfall 011 07-12-10 (After)

Figure 16.10. Outfall 015, EU02 11-12-09 (Before)

Figure 16.11. Outfall 015, EU02 11-12-09 (Before)

Figure 16.12. Outfall 015 EU03 11-12-09 (Before)

Figure 16.13. Outfall 015 EU03 11-12-09 (Before)

Figure 16.14. Outfall 015 EU04 11-12-09 (Before)

Figure 16.15. Outfall 015 EU04 11-12-09 (Before)

Figure 16.16. Outfall 015 EU04 11-12-09 (Before)

Figure 16.17. Outfall 015 EU07 1112-09 (Before)

Figure 16.18. Outfall 015 EU08 11-12-09 (Before)

Figure 16.19. Outfall 015, EU 02 07-12-10 (After)

Figure 16.20. Outfall 015, EU 02/03 07-12-10 (After)

Figure 16.21. Outfall 015, EU 03 07-12-10 (After)

Figure 16.22. Outfall 015, Eu 04 07-12-10 (After)

Figure 16.23. North South Diversion Ditch Section 3, EU 01 11-12-09 (Before)

Figure 16.24. North South Diversion Ditch Section 3, E U01 11-12-09 (Before)

Figure 16.25. North South Diversion Ditch Section 3, EU 02 11-12-09 (Before)

Figure 16.26. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.27. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.28. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.29. North South Diversion Ditch Section 5 11-12-09 (Before)

Figure 16.30. North South Diversion Ditch Section 3 EU 01 07-13-10 (After)

Figure 16.31. North South Diversion Ditch Section 3 EU 02 07-13-10 (After)

Figure 16.32. North South Diversion Ditch Section 3 EU 03 07-13-10 (After)

Figure 16.33. North South Diversion Ditch Section 5 07-13-10 (After)

17. C-749 URANIUM BURIAL GROUND

The *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, was signed in 1995 (DOE 1995d). Because SWMU 3, the C-404 Contaminated Burial Ground, is closed with a RCRA cap and is being addressed by RCRA postclosure permit requirements, the 1995 ROD required no further action for it. For SWMU 2, the C-749 Uranium Burial Ground, the interim ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls. Through agreement by the parties, an impermeable cap was not constructed [WAG 22 Post-ROD Change, October 23, 1996 (Hodges 1996)]. Fieldwork to collect data for the final actions for the BGOU RI was performed in 2007 and the RI report was completed in 2010 (DOE 2010e). An FS is underway to evaluate final remedial actions for SWMUs 2 and 3. Figure 17.1 illustrates the location of SWMU 2.

This IRA in the 1995 ROD leaves waste in place that requires restricted access; therefore, SWMU 2 will be reviewed no less than once every five years. In addition to the Five-Year Review, the ROD states that the groundwater data will be evaluated annually. These evaluations are documented in the FFA Semiannual Reports. The November 2012 report contains a map depicting the SWMU 2 groundwater MWs and a summary of the SWMU 2 trends for TCE and Tc-99 for reporting dates 1996 through July 2012 (DOE 2012a).

DOE conducted an investigation at SWMU 2 to provide information needed before the selected interim action was fully implemented and to provide additional data to evaluate a final remedial action for SWMU 2 (DOE 1997b). One of the goals of this investigation was to determine if the waste within SWMU 2 was saturated with groundwater. The results of the investigation indicated that the waste within SWMU 2 was saturated; therefore, placement of a cap on SWMU 2, and the design and construction activities outlined within the ROD were canceled (Hodges 1996). The following are the conclusions of the investigation.

- Uranium and uranium precipitate dissolver sludge, contaminated with TCE from the C-400 Cleaning Building, is the primary component of the buried waste (with minimal, associated PCB oil).

- Migration of contaminants from the waste cell and underlying contaminated soil may have contributed to TCE at the PGDP boundary in concentrations that exceed both human health risk-based and regulatory (i.e., MCL) PRGs; however, modeling indicates that migration of radionuclides is not a concern.

- Lateral movement of groundwater in the UCRS does occur, but not to a significant extent. Vertical transport of TCE is significant, but vertical transport of uranium is not significant.

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the C-749 Uranium Burial Ground is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

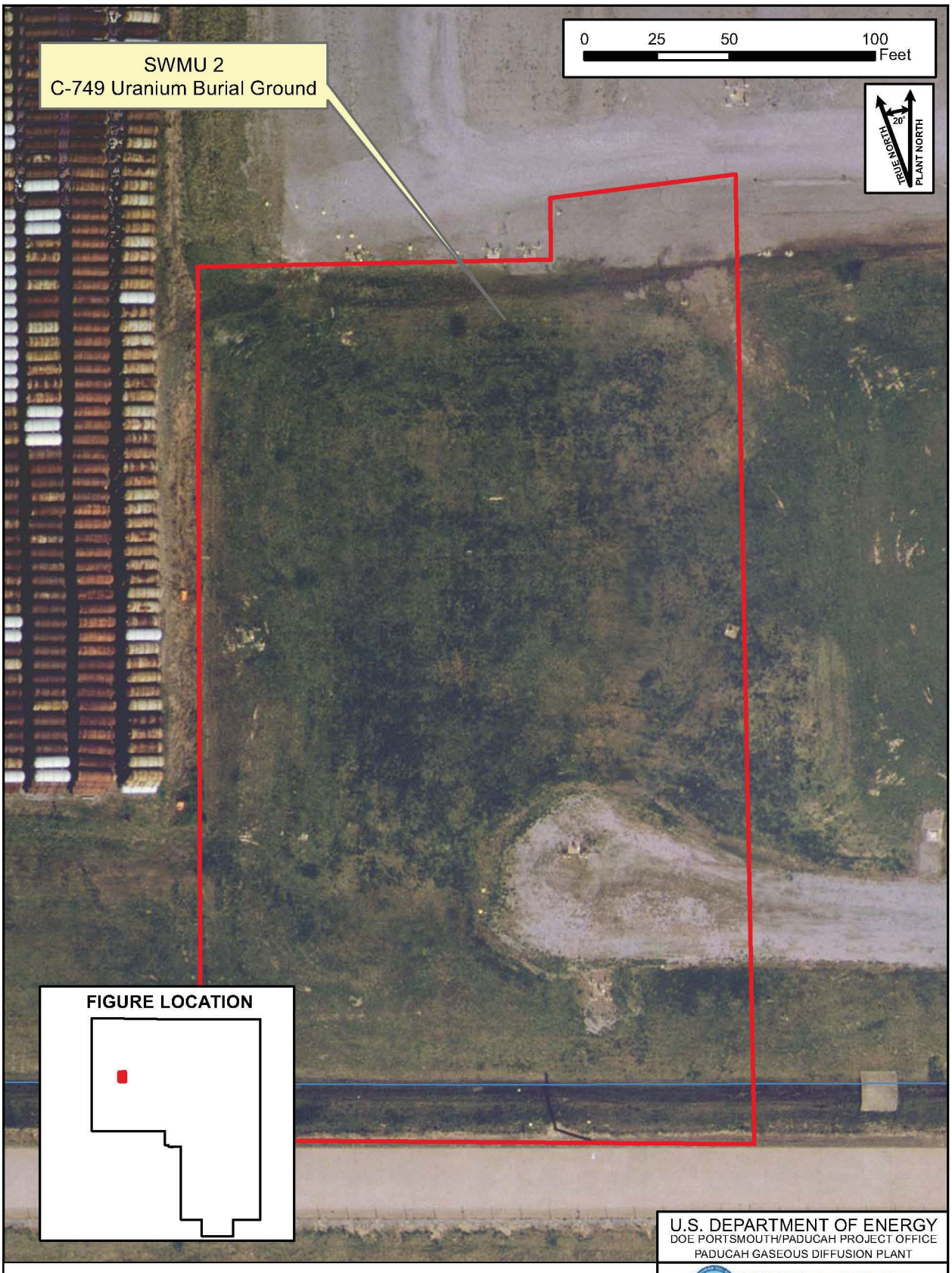

Figure 17.1. Location of C-749 Uranium Burial Ground

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

LATA Environmental Services of Kentucky, LLC

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3/12/2013

17.1 REMEDY SELECTION

The RAOs for the interim action were to mitigate migration of uranium and TCE from SWMU 2 to groundwater, and to prevent disturbance or contact with the buried waste materials. To accomplish this, the selected IRA, Alternative 5, consisted of installation of the following components:

- Once a determination has been made regarding possible ground water interaction with the buried wastes, a low permeability, multilayered cap may be placed on SWMU 2, the C-749 Uranium Burial Ground, to reduce infiltration of surface water from precipitation events into and through buried wastes. This will also reduce potential leaching of contaminants to ground water. The cap will also decrease the gamma exposure rate to background levels and further decrease the likelihood of on-site workers and terrestrial animals coming into direct contact with the buried wastes;

- A ground water monitoring program will be implemented in the uppermost aquifer, the Regional Gravel Aquifer, to detect any release of contaminants from SWMU 2; and

- Institutional controls will be implemented to prevent transferal of the SWMU 2 property and prevent to future intrusive activities at the unit (DOE 1995d).

The low-permeability, multilayered cap would be constructed over SWMU 2 to reduce significantly the infiltration of surface water from precipitation events into the unit.

A groundwater monitoring program would be established in the RGA to detect potential contaminants released from SWMU 2. A monitoring program also would evaluate the cap's effect(s) on the shallow groundwater level in the UCRS and fill data gaps.

Institutional controls would be implemented to further prevent access to SWMU 2. These institutional controls may include a deed restriction to ensure that DOE retains ownership of the property, which SWMU 2 encompasses. Institutional controls also may prevent inappropriate use of the property and any intrusive activities that could expose buried waste materials.

Additionally, DOE would conduct reviews of the action no less than once every five years.

17.2 REMEDY IMPLEMENTATION

Following the post-ROD investigation, it was determined that the multilayer low-permeability cap, which was meant to minimize vertical infiltration of rain water through unsaturated waste, would be ineffective because of the shallow groundwater found at SWMU 2. This investigation fulfilled the IRA requirement to evaluate the cap's effect(s) on the shallow groundwater level in the UCRS and fill data gaps. As a result, the multilayer low-permeability cap installation was cancelled (Hodges 1996).

In 1996, three RGA MWs were constructed to detect potential releases from SWMU 2. MW337 and MW338 were installed downgradient of SWMU 2, and MW333 was installed upgradient of SWMU 2. The wells currently are sampled as part of the PGDP Groundwater Monitoring Program as specified in the EMP (LATA Kentucky 2012b).

Since the ROD for this IRA was signed prior to the effective date of the PGDP MOA and LUCAP, a LUCIP does not exist for the institutional controls at SWMU 2.

DOE remains in control of the property that SWMU 2 encompasses. No deed restriction has been filed as part of this IRA. Exposure pathways that could result in unacceptable risk are being controlled through DOE ownership and use of the property.

17.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

On February 12, 2013, a site inspection of the SWMU 2 was performed. This area is located north and west of the C-600 Building within the boundaries of the controlled access area of PGDP. There were no indications of erosion or standing water in the area. An access road is located on the south side of the area outside the radiological boundary. The road is maintained well and is in good condition. Access to the north side of the area is through the C-745-C Cylinder Storage yard. This area also is maintained well. The area was covered with grass and it is mowed and well maintained. MWs in the area appear to be in good condition and are well maintained. The wells are secured with protective caps and casings with locks and are surrounded with guard posts.

17.4 TECHNICAL ASSESSMENT

The RAOs for the interim action were to mitigate migration of uranium and TCE from SWMU 2 to groundwater and to prevent disturbance or contact with the buried waste materials.

The SWMU 2 low-permeability, multilayered cap was intended to mitigate migration of uranium and TCE from SWMU 2 to groundwater; however, this action was cancelled after it was determined that it would be ineffective because of the shallow groundwater found at SWMU 2.

The maximum detected concentrations of TCE in the one upgradient well and the three downgradient RGA wells located at SWMU 2 currently exceed the National Primary Drinking Water Standards and applicable state standards. Tc-99 activity has remained below the MCL, but appears to be rising in SWMU 2 downgradient well, MW337.

The RAO to prevent disturbance or contact with buried waste material is being met, and the current action is protective of human health by preventing human exposure to buried wastes and groundwater through rigorous operational controls (i.e., radiological postings, radiological work permits, and excavation permits).

Tables 17.1 and 17.2 present downgradient vs. upgradient data showing a comparison of the initial (i.e., pre-1996) and current maximum concentrations of the principal contaminants detected in RGA wells at SWMU 2, based on groundwater sampling conducted between 1996 and 2012. The maximum detected concentrations of TCE in the one upgradient well and the three downgradient RGA wells (MW337, MW338, and MW67) located at SWMU 2 currently exceed the EPA Primary Drinking Water Standard MCL (5 µg/L) and comparable Kentucky MCL used for screening the results. Tc-99 activity has remained below the MCL of 4 mrem (interpreted by EPA to be equivalent to 900 pCi/L).

Concentrations of uranium currently are at nondetectable levels and have been previously, with the exception of two sampling events in downgradient well MW338. In one event, uranium was detected at a high level (350 µg/L on September 24, 2001), but subsequent sampling at the well and isotopic uranium analysis of the same sample show nondetectable levels;[4] therefore, the credibility of the high result is

[4] The laboratory reporting limit for uranium typically is 1 µg/L or less.

Table 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
TCE	0.003	MW50	11/10/1988 10/15/1991 1/29/1992 7/28/1992 10/7/1992	2.3 2.3	MW337 MW67	5/11/2009 8/5/2009	No Value	0.005	mg/L
Uranium	0.001	MW51	5/1/1991	0.35[b]	MW338	9/24/2001	0.002	0.03	mg/L
cis-1,2-DCE	Not Analyzed	N/A	ALL	0.160	MW 67	2/3/2009	No Value	0.07	mg/L
Beryllium	0.0023	MW50	4/5/1990	0.0014	MW337	10/4/1996	0.004	0.004	mg/L
Calcium	16.8	MW50	10/20/1989	16	MW337	10/4/1996	40	No Value	mg/L
Chloride	13	MW67	2/18/1988	24.3	MW338	3/10/1998	89.2	250[c]	mg/L
Fluoride	0.89	MW51	5/1/1991	0.41	MW338 MW67	10/4/1996 10/8/1996	0.245	4	mg/L
Iron	82.8	MW50	10/20/1989	56	MW337	10/4/1996	3.72	0.3[c]	mg/L
Magnesium	6.43	MW67	2/24/1993	7.3	MW337	10/4/1996	15.7	No Value	mg/L
Manganese	1.8	MW51	1/13/1988	2.1	MW337	10/4/1996	0.082	0.05[c]	mg/L
Nitrate/Nitrite	0.07	MW50	4/5/1990	0.21	MW337	10/4/1996	13.5[d]	10[d]/1[d]	mg/L
Potassium	2.38	MW50	10/20/1989	3.9	MW337	10/4/1996	4.47	No Value	mg/L
Sodium	333	MW50	10/20/1989	14	MW338	10/4/1996	63.5	No Value	mg/L
Sulfate	12	MW67	2/24/1993	8.7	MW67	10/8/1996	19.1	No Value	mg/L

Table 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2 (Continued)

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
Vanadium	0.0568	MW50	10/20/1989	0.052	MW337	10/4/1996	0.139	No Value	mg/L
Gross Alpha	33.3[e]	MW67	11/17/1988	10.8	MW337	12/4/2003	2.36	15	pCi/L
Gross Beta	38 38[e]	MW50 MW51	10/20/1989 3/28/1991	196	MW337	9/25/2009	7.3	50[f]	pCi/L
Am-241	1.6	MW51	1/13/1988	0.35	MW67	10/8/1996	No Value	No Value	pCi/L
Pu-239	0.28	MW67	3/11/1991	0.13	MW338	10/4/1996	0.03	No Value	pCi/L
Tc-99	53.2	MW51	7/23/1992	347	MW337	8/10/2011	10.8	900	pCi/L
Th-230	ND	N/A	ALL	0.74	MW67	10/8/1996	0.54	No Value	pCi/L
U-234	2.5	MW67	3/11/1991	0.56	MW338	10/4/1996	0.7	10.24[h]	pCi/L
U-235/U-236	ND	N/A	ALL	0.11	MW337	10/4/1996	0.3[g]	0.466[h]	pCi/L
U-238	3.3	MW67	3/11/1991	0.67	MW338	10/4/1996	0.7	9.99[h]	pCi/L

ND = not detected.
N/A = not applicable
[a] Background values of RGA wells from Volume 5 of the GWOU FS, *Background Concentrations of Naturally Occurring Inorganic Chemicals and Selected Radionuclides in the Regional Gravel Aquifer and McNairy Formation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (Volume 5 of the GWOU FS) (DOE 2001a).
[b] Isolated detection, isotopic analysis shows nondetects.
[c] Secondary MCL for reference only.
[d] Value is nitrate as nitrogen.
[e] Dissolved activity.
[f] 401 *KAR* 47:030 value.
[g] Background value for U-235.
[h] 2013 Update of the Human Health Risk Methods Document (DOE 2013b).

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
TCE	ND	N/A	ALL	7.1	MW333	5/7/2009	No Value	0.005	mg/L
Uranium	0.019	MW48	8/1/1989	ND	N/A	ALL	0.002	0.03	mg/L
cis-1,2-DCE	Not Analyzed	N/A	ALL	0.770	MW333	5/7/2009 3/8/2010	No Value	0.07	mg/L
Beryllium	0.01	MW48	8/1/1989	ND	N/A	ALL	0.004	0.004	mg/L
Calcium	17.2	MW48	4/3/1991	24.0	MW333	10/14/1996	40	No Value	mg/L
Chloride	12	MW48	3/9/1993	12.1	MW333	3/10/1998	89.2	250[b]	mg/L
Fluoride	0.18	MW48	5/24/1989	0.32	MW333	10/14/1996	0.245	4	mg/L
Iron	706	MW48	8/1/1989	6.2	MW333	10/14/1996	3.72	0.3[b]	mg/L
Magnesium	6.99	MW48	4/3/1991	9.2	MW333	10/14/1996	15.7	No Value	mg/L
Manganese	5.87	MW48	8/1/1989	2.6	MW333	10/14/1996	0.082	0.05[b]	mg/L
Nitrate/Nitrite	1.9[c]	MW48	12/11/1991	0.05	MW333	10/14/1996	13.5[c]	10[c]/1[d]	mg/L
Potassium	2.07	MW48	10/13/1989	1.2	MW333	10/14/1996	4.47	No Value	mg/L
Sodium	13.7	MW48	4/3/1991	16	MW333	10/14/1996	63.5	No Value	mg/L
Sulfate	12	MW48	3/9/1993 12/11/1992	16	MW333	10/14/1996	19.1	No Value	mg/L
Vanadium	0.0085	MW48	10/13/1989	0.0097	MW333	10/14/1996	0.139	No Value	mg/L
Gross Alpha	20.4[e]	MW48	1/13/1988	4.34	MW333	3/19/2007	2.36	15	pCi/L

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2 (Continued)

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
Gross Beta	23[e]	MW48	1/13/1988	24.7	MW333	3/8/2010	7.3	50[f]	pCi/L
Am-241	3.7	MW48	3/27/1991	0.19	MW333	10/14/1996	No Value	No Value	pCi/L
Pu-239	ND	N/A	ALL	ND[h]	N/A	ALL	0.03	No Value	pCi/L
Tc-99	33	MW48	8/1/1989	39.9	MW333	5/7/2009	10.8	900	pCi/L
Th-230	ND	N/A	ALL	0.25	MW333	10/14/1996	0.54	No Value	pCi/L
U-234	ND	N/A	ALL	9.66	MW333	10/14/1996	0.7	10.24[i]	pCi/L
U-235/U-236	ND	N/A	ALL	0.35	MW333	10/14/1996	0.3[g]	0.466[i]	pCi/L
U-238	1.3	MW48	4/3/1991	0.14	MW333	10/14/1996	0.7	9.99[i]	pCi/L

ND = not detected.
N/A = not applicable
[a] Background values of RGA wells from Volume 5 of the GWOU FS, *Background Concentrations of Naturally Occurring Inorganic Chemicals and Selected Radionuclides in the Regional Gravel Aquifer and McNairy Formation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (Volume 5 of GWOU FS) (DOE 2001a).
[b] Secondary MCL for reference only.
[c] Value is nitrate as nitrogen.
[d] Value is nitrite as nitrogen.
[e] Dissolved activity.
[f] 401 *KAR* 47:030 value.
[g] Background value for U-235.
[h] Value reported below laboratory detection limit, but was not laboratory qualified as a nondetect.
[i] 2013 Update of the Human Health Risk Methods Document (DOE 2013b).

questionable. The second event shows that another detection (1.6 µg/L on December 3, 2002) was below the level established for RGA background (2 µg/L) and was followed by analyses that reported nondetectable concentrations.

Figure 17.2 illustrates TCE trends in upgradient MW333 and downgradient wells MW337, MW338, and MW67. These data show that TCE concentrations are higher in upgradient MW333 than the downgradient wells. These data indicate that TCE contamination in the RGA at SWMU 2 is coming from an upgradient source and that the net groundwater flow direction is northward. See Figure 17.3 for RGA well locations.

Figure 17.2 illustrates the potentiometric surface in the vicinity of SWMU 3 and SWMU 2 on July 17, 2012. There is a northerly gradient (compare 324.82 ft elevation at upgradient MW333 with 324.45 ft elevation downgradient MW338). The slight easterly vector of groundwater gradient likely is related to the fact that SWMU 3 has an impermeable (RCRA-equivalent) cap that limits infiltration in the vicinity of the unit. This will slightly depress the water table in the vicinity of SWMU 3 and induce some flow to the east, as shown on Figure 17.3, especially during periods of higher infiltration. A review of the shape of the TCE plume 100 µg/L implied contour (See Figure 17.4) supports the finding that the net groundwater flow is to the north, with some seasonal flow to the northwest and some to the northeast.

Because SWMU 2 is located inside the plant secured area and under DOE ownership and control, deed restrictions have not been necessary. SWMU 2 is roped and posted along the perimeter of the unit to identify it as a radiological contamination zone requiring personal protective equipment, special training, and permits to gain access or to work within the area.

17.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

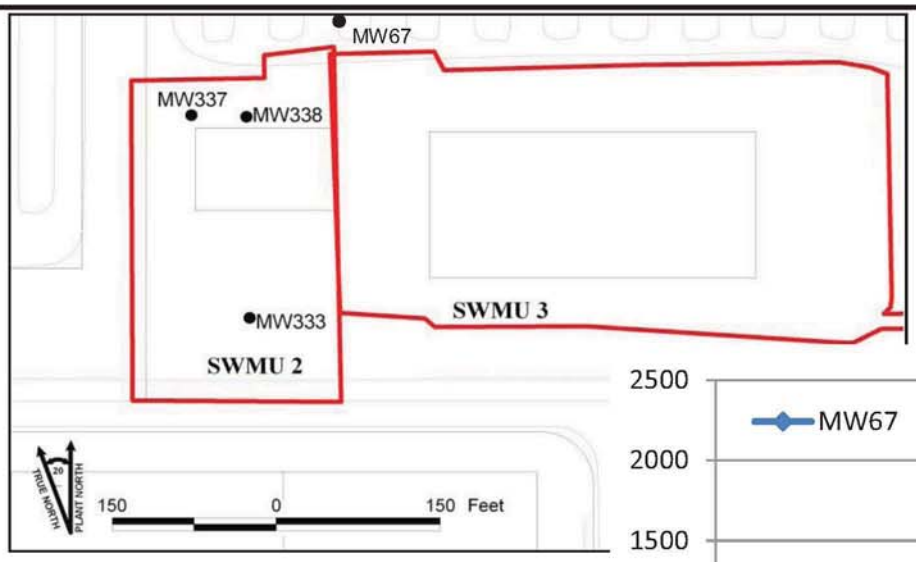
The components of the remedy that were implemented are functioning as intended. Groundwater MWs constructed for SWMU 2, consisting of two downgradient wells (MW337 and MW338) and one upgradient well (MW333), are located to monitor the facility. Furthermore, a previously existing RGA well (MW67) provides additional downgradient monitoring.

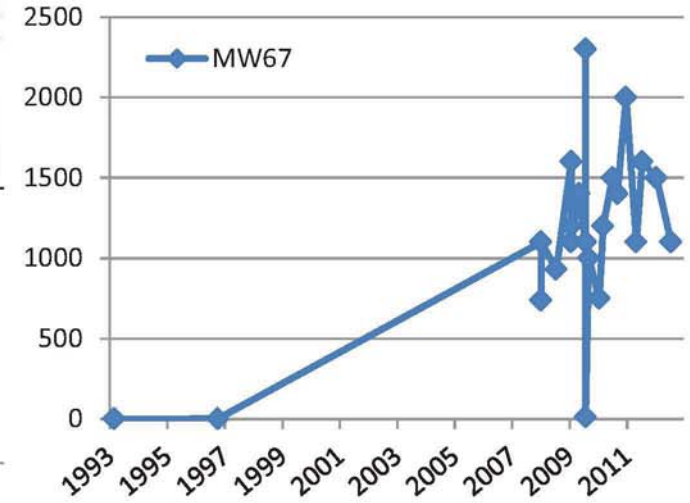
17.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

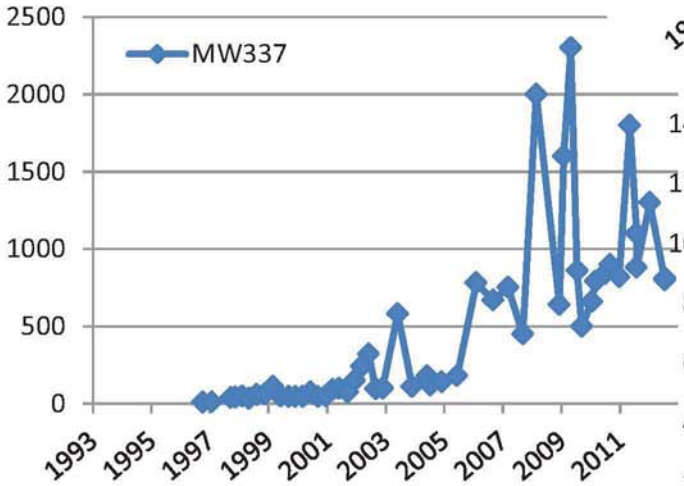
DOE remains in control of the property that SWMU 2 encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the buried waste materials remains valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants identified.

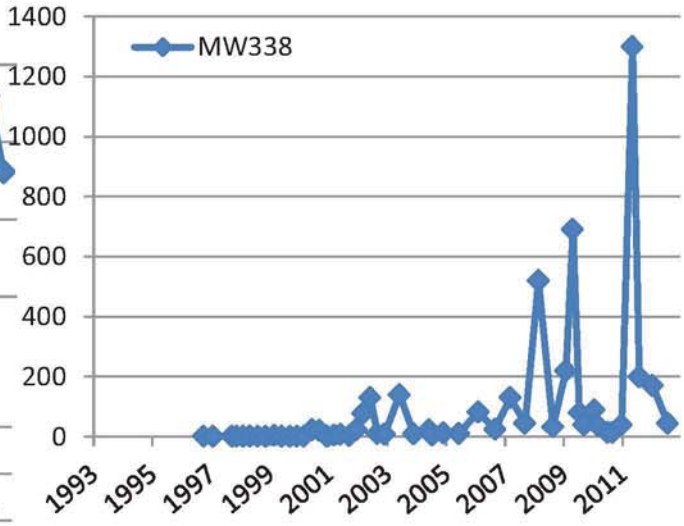
The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. The post ROD monitoring program evaluated the proposed cap's effect on the shallow groundwater level and identified that the UCRS water levels in the waste were predominately saturated and the installation of the cap would not reduce potential groundwater contamination. Based on this conclusion by the parties, implementation of the cap's design and construction activities as outlined in the current ROD was canceled (Hodges 1996).

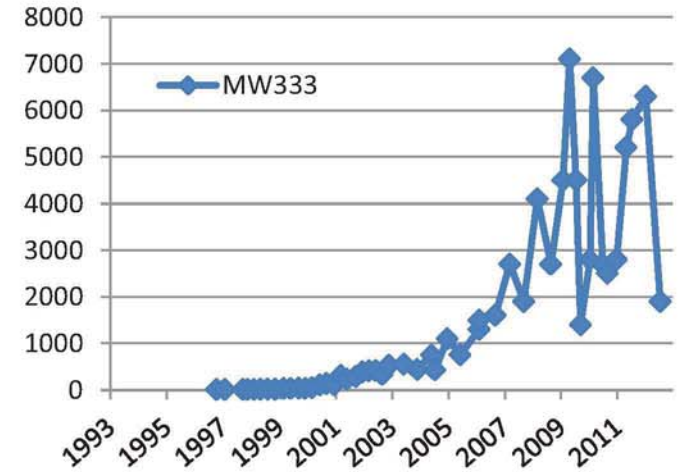
The exposure assumptions used to develop the Human Health Risk Assessment included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker).The MCL for TCE remains 0.005 mg/L as it was during the original remedy selection; however, the original remedy was based on the assumption that there is no exposure pathway because institutional controls prevent access to the groundwater at the unit. The changes to the parameters for risk











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PADUCAH GASEOUS DIFFUSION PLANT

Figure 17.2. TCE Trends in the Upper RGA for SWMU 2

LATA Environmental Services of Kentucky, LLC

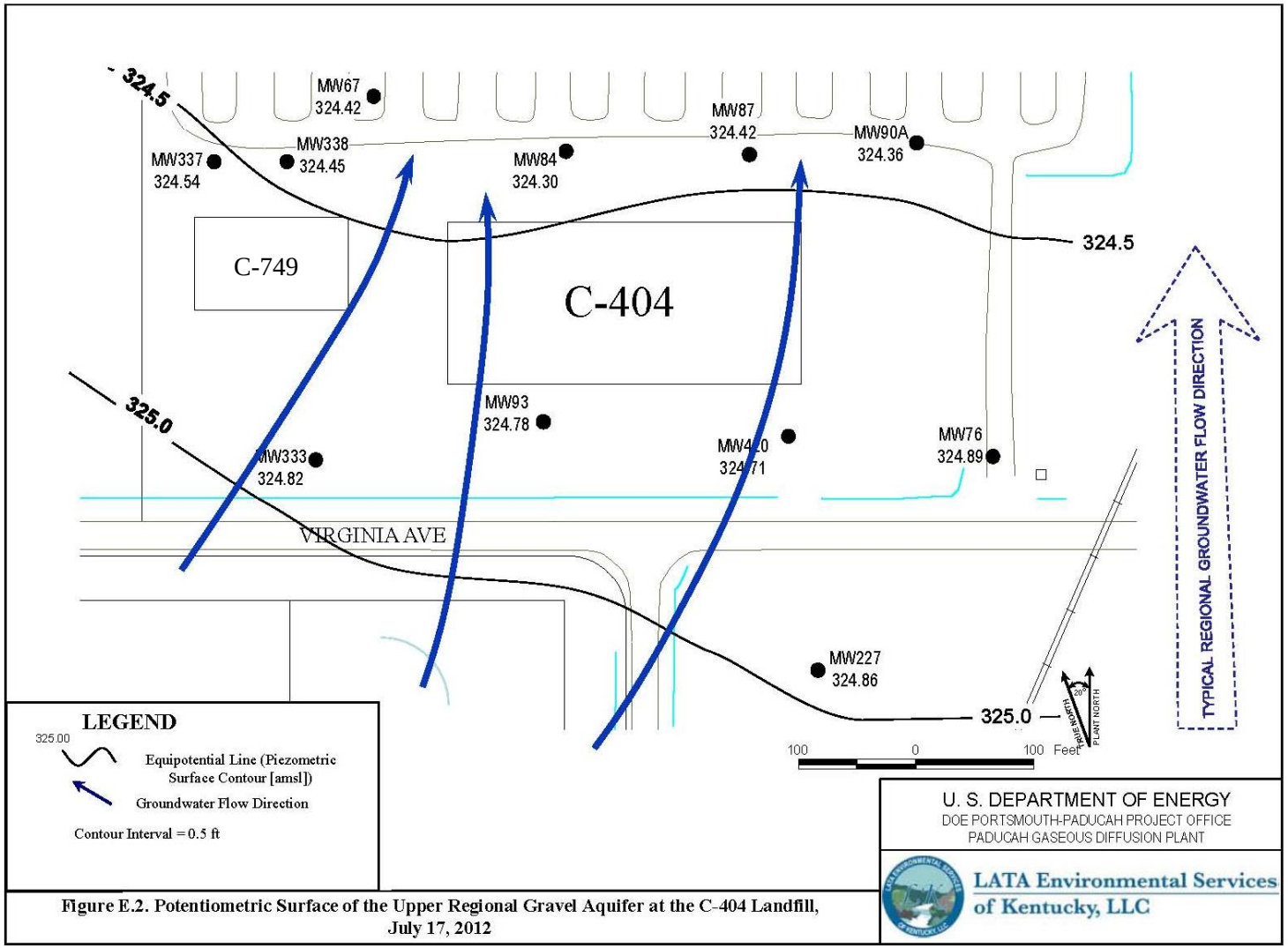

Figure E.2. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 Landfill, July 17, 2012

Figure from LATA Kentucky 2012d

Figure 17.3. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 (SWMU 3) and C-749 (SWMU 2) Landfills, July 17, 2012

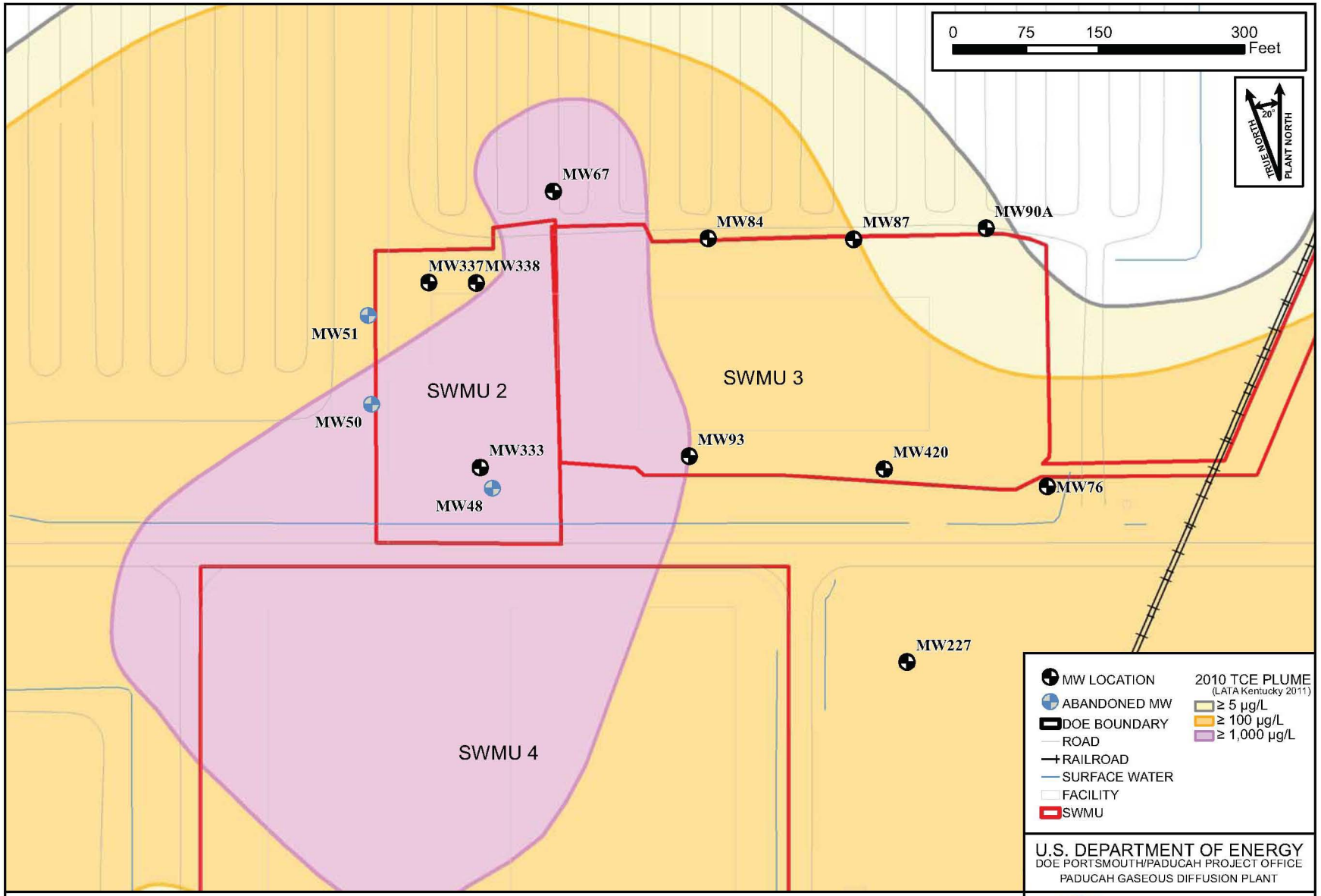

Figure 17.4. Location of C-749 (SWMU 2) and Trichloroethene Groundwater Plume

evaluation of TCE, therefore, have no effect on the protectiveness of the remedy because the exposure assumption (no exposure) is still valid. The recent data also indicate that contaminants in groundwater from this unit do not contribute significantly to the area-wide groundwater contamination that is being addressed through other actions.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal of the waste and impacted soils.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

17.4.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

For those remedy components that were implemented, no additional information has come to light since implementation of the remedy that could call into question their protectiveness.

17.5 ISSUES

None.

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18. ISSUES

Issues identified during this Five-Year Review are summarized here for each action. Recommendations are summarized in the following section.

18.1 NORTHWEST PLUME

None.

18.2 NORTHEAST PLUME

None.

18.3 CYLINDER DROP TEST AREA OR LASAGNA™

None.

18.4 WATER POLICY

All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all landowners have signed license agreements on file for their properties; therefore, potential risk exists that residents would use their groundwater.

18.5 C-400 ELECTRICAL RESISTANCE HEATING

The ROD selected ERH to address the VOC source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting the RAOs in the UCRS and the upper RGA; however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.

18.6 SOUTHWEST PLUME

None.

18.7 NSDD SOURCE CONTROL

None.

18.8 NSDD SECTIONS 1 AND 2

None.

18.9 C-746-K LANDFILL

None.

18.10 FIRE TRAINING AREA

None.

18.11 SURFACE WATER INTERIM CORRECTIVE MEASURES

None.

18.12 SURFACE WATER ON-SITE SEDIMENT REMOVAL

None.

18.13 C-749 URANIUM BURIAL GROUND

None.

19. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based upon the issues for each remedial action identified during this review, Table 19.1 identifies recommendations and follow-up actions.

Table 19.1. Recommendations and Follow-up Actions from 2013

Issue	Recommendations/Follow-up Actions
C-400 Electrical Resistance Heating	
The ROD selected ERH to address the VOC source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting the RAOs in the UCRS and the upper RGA; however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.	Evaluate alternative technologies to achieve the RAO for the lower RGA (reduce the extent and mass of the VOC source). The FFA parties have agreed to conduct a treatability study to support remedy selection for the lower RGA. Upon completion of the treatability study, the FFA parties will determine the path forward for treatment of the lower RGA, and the decision documents for implementation will be modified as appropriate.
Northeast Plume	
Not Applicable.	The FFA parties recommended optimization of the Northeast Plume treatment system to increase TCE and 1,1-DCE mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The recommendation for optimization is planned for FY 2013/2014. An evaluation of the results of the optimization of the Northeast Plume with field testing and use of the sitewide groundwater flow model is needed to understand the performance of the new EWs.
Water Policy	
All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all landowners have signed license agreements on file for their properties; therefore, potential risk exists that residents would use their groundwater.	DOE will optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater. An annual educational fact sheet will be sent to each address within the Water Policy Box. Such a fact sheet would outline the potential risk associated with the groundwater and inform residents within the Water Policy Box of the groundwater remediation. Land ownership also will be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box. The newly identified owners will be contacted and given information concerning the contaminated groundwater. Raising the education and awareness levels about the potential risk associated with the groundwater will reduce the likelihood that residents would use their groundwater.

Table 19.1. Recommendations and Follow-up Actions from 2013 (Continued)

Issue	Recommendations/Follow-up Actions
NSDD Section 1 and 2	
Not Applicable.	Based on the residual risk evaluation concluding that the remaining contamination poses minimal risk based on the current and reasonably anticipated industrial exposure scenario, a request for modification of the NSDD LUCIP will be submitted for the monitoring of the LUCs to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing annual verification of administrative controls and annual verification of access to once every five years for the NSDD Sections 1 and 2.
C-746-K Landfill	
Not Applicable.	The shaft of MW301 has buckled so that repair/replacement of the pump would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.
Surface Water Interim Corrective Measures	
Not Applicable.	An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water ICM signs with EI signs, which serve to meet the objectives of the ICM signs. Specifically, where the signs are co-located, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. The fencing located at areas A7 and A8 will be removed, and signs located at A1 will be removed (see Figure ES.1).

As the lead agency, DOE is responsible for implementing these recommendations. EPA and the Commonwealth of Kentucky will provide oversight. DOE will interface with EPA and the Commonwealth of Kentucky, as necessary, to implement these recommendations.

20. 2013 PROTECTIVENESS STATEMENTS

Overall, the selected remedies implemented thus far are protective, but PGDP cleanup activities are still ongoing with additional future actions planned. The groundwater exposure pathways for PGDP are being controlled by providing affected residents access to municipal water under the Water Policy, combined with a series of source and plume control actions to reduce off-site contaminant migration. Other exposure pathways for other media (e.g., soil and sediment) are being controlled through individual OU actions along with DOE ownership and use of the property.

20.1 GROUNDWATER OPERABLE UNIT

20.1.1 Northwest Plume

The remedy for the Northwest Plume is protective of human health and the environment.

The objective of this IRA is to initiate control of the source and mitigate the spread of contamination in the Northwest Plume. The optimization of the Northwest Plume IRA is intended to increase VOC mass removal and enhance the contaminant capture in the vicinity of the existing south wellfield located immediately north of the plant. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

20.1.2 Northeast Plume

The remedy for the Northeast Plume is protective of human health and the environment.

The objective of this IRA is to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the plant security fence. Optimization of the Northeast Plume is being pursued by the FFA parties. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

20.1.3 Cylinder Drop Test Area

The remedy for the Cylinder Drop Test Area is protective of human health and the environment.

The RAO for this remedy is intended to prevent rural residents from exposure to the only COC, TCE. This RAO has been met through treatment of soils to a concentration below cleanup goals, thereby reducing the amount of TCE available to leach to groundwater.

20.1.4 Water Policy

The remedy for the Water Policy is protective of human health and the environment.

The objective of this removal action is to prohibit the use of contaminated groundwater and provide a safe, alternate water supply to the residents in the affected area. This objective has been met by providing affected residents access to municipal water in accordance with the Water Policy and corresponding license agreements, thereby reducing opportunities for exposure to contaminated groundwater.

20.1.5 C-400 Electrical Resistance Heating

The IRA for the VOC contamination at C-400 is expected to contribute to protectiveness of human health and the environment upon completion. In the interim, remedial activities completed to date have addressed adequately all exposure pathways that could result in unacceptable risks in these areas.

20.1.6 Southwest Plume

The remedial action for VOC sources at Southwest Plume is expected to contribute to protectiveness of human health and the environment upon completion. In the interim, remedial activities completed to date have addressed adequately all exposure pathways that could result in unacceptable risks in these areas.

20.2 SURFACE WATER OPERABLE UNIT

20.2.1 NSDD Source Control

The remedy for the NSDD Source Control is protective of human health and the environment.

The objective of this IRA is to initiate control of the source of continued contaminant releases into the NSDD and mitigate the spread of contamination from the NSDD. This objective was achieved by mitigating the discharge of contaminants into NSDD, institutional controls to limit the potential for direct exposure, and engineering controls to mitigate the infiltration and migration of contaminants from the NSDD to the subsurface environment and off-site (i.e., outside the existing security fence).

20.2.2 NSDD Sections 1 and 2

The removal action for the NSDD Sections 1 and 2 is protective of human health and the environment.

The ROD established the following RAOs: prevention of future discharge of process water to the NSDD; reduction of the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water; and prevention of future on-site runoff from being transported off-site (i.e., outside the existing security fence) via the NSDD. The RAOs have been achieved effectively through excavation of contaminated sediment and placement of clean soil to meet the cleanup goal and implementation of LUCs assuring protectiveness.

20.2.3 C-746-K Landfill

The remedy for the C-747-K Landfill is protective of human health and the environment.

The RAOs for this unit are to control the release of COCs from the unit, limit direct contact by humans, and reduce overall risks to ecological receptors. The RAOs have been met through the reduction of human risks by posting warning signs and other institutional controls and through the reduction of ecological risks by installing riprap over exposed acidic leachate seeps.

20.2.4 Fire Training Area

The remedy for the Fire Training Area is protective of human health and the environment.

The selected remedy for the Fire Training Area, which rested upon the surrounding area remaining industrialized, is no further action (outside of maintaining institutional controls). The same land use that

was in place and relied upon to support no further action still is in place and remains effective. This also is consistent with the expected future use of the area, as described in the SMP.

20.2.5 Surface Water Interim Corrective Measures

The remedy for the surface water ICMs is protective of human health and the environment.

The objective of the surface water ICMs work plan is to design a system of institutional controls that will identify the areas of contamination through posting warning signs and restrict casual public access to the creeks. This objective has been met through posting warning signs and constructing fences near bridges crossing affected streams. These institutional controls serve to inform the public about the areas of contamination, resulting in a reduction of casual public access to the streams.

20.2.6 Surface Water On-site Sediment Removal

The remedy for the Surface Water On-site Sediment Removal is protective of human health and the environment.

The RAOs for this unit were to ensure that direct contact risk at the on-site ditches for the current industrial worker falls within the EPA risk range and to ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range. These RAOs were met by excavating contaminated sediment/soil and placing clean soil to meet the cleanup goal.

20.3 BURIAL GROUNDS OPERABLE UNIT

20.3.1 C-749 Uranium Burial Ground

The remedy for the C-749 Uranium Burial Ground is protective of human health and the environment.

The RAOs for the interim action were to mitigate migration of uranium and TCE from the C-749 Uranium Burial Ground to groundwater and to prevent disturbance or contact with the buried waste materials. The interim ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls. The interim action, as implemented, provides protection by mitigating direct contact with the buried waste through DOE ownership and use of the property. Alternatives for final action at SWMU 2 currently are being evaluated under the SWMUs 2, 3, 7, and 30 BGOU FS.

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21. NEXT REVIEW

The next Five-Year Review for PGDP is required to be approved by the FFA parties by December 30, 2017. Note: These schedules are estimates for planning and are included for informational purposes only and are not intended to establish enforceable schedules or milestones. Enforceable milestones are contained in Appendix C of the FFA and Appendix 5 of the SMP. All remedial actions discussed within this text, in addition to any new actions initiated or completed within the next five years, will be included in that review.

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22. FIVE-YEAR REVIEW PROCESS

22.1 ADMINISTRATIVE COMPONENTS

DOE's environmental remediation subcontractor performed this Five-Year Review. The reviews were conducted during January through April 2013. Components of this review are as follows:

- Document review
- Data review
- Site inspection
- Interviews of personnel responsible for specific aspects of some of the response actions
- Five-Year Review Report development and review

22.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Community involvement at PGDP is handled primarily in conjunction with the CAB. The CAB meets monthly to discuss many aspects of environmental restoration efforts at PGDP. Copies of AR decision documents are kept at the Environmental Information Center (EIC). The EIC is open to the public during regular business hours. DOE published a public notice in the local newspaper on March 17, 2013, announcing the Five-Year Review had been initiated and requested that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. No comments were received.

22.3 DOCUMENT REVIEW

This activity consisted of a review of relevant documents to the remedial action of each of the units and the previous Five-Year Reviews. This was conducted during January through April 2013. These documents are included as references in Chapter 23.

22.4 DATA REVIEW

Groundwater, surface water, and sediment samples are collected routinely at PGDP to assess environmental conditions. These data are stored in Paducah's Oak Ridge Environmental Information System (Paducah OREIS). Data were downloaded for review from Paducah OREIS throughout the review process.

22.5 SITE INSPECTIONS

Inspections were conducted at each of the response action sites during January and February 2013. The DOE contractor conducted the inspections. Results of the inspections are discussed in each respective response action sections. The scope of the inspections was to verify that the selected remedy in the decision document remained protective.

22.6 INTERVIEWS

Interviews were conducted during February, March, and April 2013 with various personnel connected to some of the response actions. Specifically, the operating engineer of the Northwest and Northeast Plumes treatment systems provided information on operation and maintenance of those systems, and the facility managers for various areas provided information on site conditions. Also, interviews, found in Appendix C, were conducted with KDWM, Kentucky Department of Fish and Wildlife, CAB, LATA Kentucky subcontractor, and local residents concerning the overall DOE project.

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APPENDIX A

ISSUES AND RECOMMENDATIONS TABLE WITH COMPLETION DATES

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Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
C-400 Electrical Resistance Heating (ERH)	The Record of Decision (ROD) selected ERH to address the volatile organic compound (VOC) source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting the remedial action objectives (RAOs) in the Upper Continental Recharge System and the upper Regional Gravel Aquifer (RGA); however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.	U.S. Department of Energy (DOE)	U.S. Environmental Protection Agency (EPA) and the Commonwealth of Kentucky	Evaluate alternative technologies to achieve the RAO for the lower RGA (reduce the extent and mass of the VOC source). The FFA parties have agreed to conduct a treatability study to support remedy selection for the lower RGA. Upon completion of the treatability study, the FFA parties will determine the path forward for treatment of the lower RGA, and the decision documents for implementation will be modified as appropriate.	TBD	N	N

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Northeast Plume	Not Applicable.	DOE	EPA and the Commonwealth of Kentucky	The FFA parties recommended optimization of the Northeast Plume treatment system to increase trichloroethene and 1,1-dichloroethene mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The recommendation for optimization is planned for FY 2013/2014. An evaluation of the results of the optimization of the Northeast Plume with field testing and use of the sitewide groundwater flow model is needed to understand the performance of the new extraction wells (EWs).	12/30/2017	N	N
Water Policy	All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all landowners have signed license agreements on file for their property; therefore, potential risk exists that residents would use their groundwater.	DOE	EPA and the Commonwealth of Kentucky	DOE will optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater. An annual educational fact sheet will be sent to each address within the Water Policy Box. Such a fact sheet would outline the potential risk associated with the groundwater and inform residents within the Water Policy Box of the groundwater remediation. Land ownership also will be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box. The newly identified owners will be contacted and given information concerning the contaminated groundwater. Raising the education and awareness levels about the potential risk associated with the groundwater will reduce the likelihood that residents would use their groundwater.	12/30/2014	N	N

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
North-South Diversion Ditch (NSDD) Sections 1 and 2	Not Applicable.	DOE	EPA and the Commonwealth of Kentucky	Based on the residual risk evaluation concluding that the remaining contamination poses minimal risk based on the current and reasonably anticipated industrial exposure scenario, a request for modification of the NSDD Land Use Control Implementation Plan will be submitted for monitoring the land use controls to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing the annual verification of administrative controls and annual verification of access to once every five years for the NSDD Sections 1 and 2.	12/30/2014	N	N
Surface Water Interim Corrective Measures (ICMs)	Not Applicable.	DOE	EPA and the Commonwealth of Kentucky	An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water ICM signs with Environmental Indicator (EI) signs, which serve to meet the objectives of the ICM signs. Specifically, where the signs are collocated, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. The fencing located at areas A7 and A8 will be removed, and signs located at A1 will be removed (see Figure ES.1).	12/30/2014	N	N
C-746-K Landfill	Not Applicable.	DOE	EPA and the Commonwealth of Kentucky	The shaft of MW301 has buckled so that any repair/replacement of the pump would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.	12/30/2014	N	N

Note: These schedules are estimates for planning. They are included only for informational purposes and are not intended to establish enforceable schedules or milestones. Enforceable milestones are contained in Appendix C of the Federal Facility Agreement and Appendix 5 of the Site Management Plan.

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APPENDIX B

2008 ISSUES, RECOMMENDATIONS, AND RESULTS

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2008 Issue	2008 Recommendations/Follow-up Actions	Results
Northwest Plume (GWOU)		
Although the remedy remains protective, the action could be optimized by ascertaining whether the high-concentration core of TCE of the Northwest Plume at the North Extraction Wellfield has migrated eastward of the capture zone of the wellfield.	Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.	In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS previously consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and will be returned to service, if needed. The location of the new EWs was optimized to capture the core and the lateral extent of the Northwest Plume in the area of the north plant boundary.
Northeast Plume (GWOU)		
The objectives of the interim ROD are being met by the interim remedial actions.	Place the system in standby mode following the development of decision criteria, which specify the conditions under which the system would be restarted.	In 2011, the FFA managers identified optimization of the Northeast Plume Containment System (NEPCS) as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of groundwater migration off DOE property followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing.
NSDD Section 1 and 2		
Not Applicable.	Perform a residual risk calculation to determine if the remedy can be optimized (e.g., risks are at a level that would support modification of institutional controls and/or cessation of five-year reviews).	The residual risk evaluation quantitatively compared the contamination left in place at the base of the NSDD excavation with outdoor and industrial worker risk-based concentrations as if the contamination were on the surface. The evaluation showed that the residual risk to these receptors falls within EPA risk range (EPA 1999); therefore, LUCs no longer should be considered necessary, provided that the current and expected future use of the area is industrial, as specified in the ROD. The evaluation also recommended continuation of the Five-Year Reviews. A request for modification of the NSDD LUCIP for removal of institutional controls is recommended.

2008 Issue	2008 Recommendations/Follow-up Actions	Results
Surface Water Interim Corrective Measures		
Signs were erected under the scope of another project. Although the message content between the signs does not conflict with each other, an evaluation of the sign program is needed.	Evaluate whether ICM signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs.	An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water ICM signs with EI signs. Specifically, where the signs are co-located, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. These actions will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. Each sign will be assigned a unique number thereby allowing the ICM locations to be identified separately for the next Five-Year Review. The fencing located at areas A7 and A8 will be removed, and signs located at A1 will be removed (see Figure ES.1).

DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
EW = extraction well
IRA = interim remedial action
KDWM = Kentucky Division of Waste Management
MW = monitoring wells
NSDD = North-South Diversion Ditch

APPENDIX C

GENERAL PGDP INTERVIEWS

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Name: **Gaye Brewer**
Affiliation: **KDWM, local resident**
Date: **March 12, 2013**

1. What is your overall impression of the project?

Response: I am glad the site is dealing with the tough issues like Burial Grounds and Groundwater and glad to see cleanup efforts moving forward.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give the purpose and results.

Response: Yes, Bill Clark (KDWM) does oversight of field activities and reports to the KY project manager what he has observed. These are brief write-ups and are mostly positive.

1. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

Response: They have received some complaints but whenever they receive one, it is investigated. None have been confirmed, to-date.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The program is professionally run and is doing a good job. One suggestion is to make sure decisions are made considering the long term.

4. What effects have site operations had on the surrounding community?

Response: Biggest effects on the community are jobs and an increase in the standard of living. There have been minimal effects environmentally.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Current community concerns are jobs. There also is interest in the Waste Disposal Options (CERCLA Cell) and where it will be located and how it will look.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: **Tim Kreher**
Affiliation: **WKWMA Manager, local resident**
Date: **April 2, 2013**

1. What is your overall impression of the project?

Response: Sometimes it is hard to see where the project is going. For example, on-site disposal facility was investigated and discussed over 10 years ago. Today we are now discussing potential sites for an on-site disposal facility. A large amount of time and money was spent in the past, why are we doing it again now?

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give the purpose and results.

Response: No.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

Response: Not to my recollection.

4. Do you feel well informed about the site's activities and progress?

Response: Yes on some issues, no on others.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: I believe that some of the people and entities involved in potential land transfer activities may not be aware of ongoing CERCLA issues with portions of the DOE property. Also, some of the sites that are being suggested for the on-site disposal facility are within the boundaries of the Environmental Assessment for DOE to transfer property to other entities. This makes little sense to me – sites need to be chosen or rejected for potential CERCLA activities before they can be giving away.

6. What effects have site operations had on the surrounding community?

Response: Many of the surrounding residents seem to have lost faith in DOE's ability to accurately convey the importance of cleanup issues at the site. I have heard neighbors say that they have begun throwing away notices of meetings, etc., because the announcements don't make sense to them.

7. Are you aware of any community concerns regarding the surrounding community?

Response: Some people seem to be concerned that cleanup activities will be affected by decreased budget and/or USEC closure. (In effect, close the doors and leave everything like it is.) Others are concerned that the potential re-industrialization of portions of the site may not be well planned out, for example, tracts of land re-industrialized in a disorganized fashion. Many recreational users of the surrounding wildlife management area would choose to see reindustrialization performed in a fashion to minimize impacts on wildlife habitat and historical recreational activities.

8. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Fish and Wildlife personnel have found evidence of illegal off-road driving taking place on DOE-owned property at the site. These infractions have been investigated and prosecuted by state and county law enforcement agencies, when applicable.

Name: **James Tortorelli**
Affiliation: **Local resident, subcontractor to LATA Kentucky**
Date: **April 8, 2013**

1. What is your overall impression of the project?

Response: I expect for DOE to do the right thing. I feel safe living in the area. I do not believe it is reasonable to expect free release of entire DOE site.

2. Do you feel well informed about the site's activities and progress?

Response: No. I think an email distribution list or website would help keep the community informed of any community meetings and updates as to what is being done.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: Not really. Every organization needs more discipline in long-term planning. DOE is doing OK.

4. What effects have site operations had on the surrounding community?

Response: Mostly psychological – lots of uncertainty in the economic future, and uncertainty in the level of hazard that exists. This causes fear. It would be nice if DOE would do a workshop on relative risk for the community and the community would attend.

5. Are you aware of any community concerns regarding the surrounding community?

Response: The plume is the biggest health concern. Then there are the economic concerns.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Not first hand. I have heard that the solar cells installed may have been vandalized but this is not confirmed.

Name: **Mike Kemp**
Affiliation: **Citizen's Advisory Board member**
Date: **April 8, 2013**

1. What is your overall impression of the project?

Response: Complicated and slow.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The perspective we have in regard to remedial activities is that all is being done. There has been a shift from remedial activities to re-use of the site over the last year. DOE leadership changes to frequently so that we do not know who is in charge from meeting to meeting. There needs to be some consistency in who is doing what.

4. What effects have site operations had on the surrounding community?

Response: Five years ago, no one cared but now, the community is energized. They are concerned about what the condition of the site is going to be left in and how it will be re-developed.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Same as previously stated (Response to question #4). USEC shutting down is of concern.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: **Resident**
Affiliation: **Resident**
Date: **April 9, 2013**

1. What is your overall impression of the project?

Response: It appears that DOE has spent a lot of money and I am not sure they have gotten their money's worth.

2. Do you feel well informed about the site's activities and progress?

Response: Maybe, I feel like DOE is trying but I have little interest as it is not a priority in my life.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: No.

4. What effects have site operations had on the surrounding community?

Response: I have heard that some people feel that their land has lost value due to the groundwater contamination. For me, it is a personal inconvenience that I cannot water my lawn or garden with my well.

5. Are you aware of any community concerns regarding the surrounding community?

Response: No.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

APPENDIX D

NSDD RESIDUAL RISK ASSESSMENT

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APPENDIX D

NSDD RESIDUAL RISK ASSESSMENT (CD)

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