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Primary Document

Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

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Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

Date Issued—September 2010

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

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

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PREFACE

This Draft *Explanation of Significant Differences to the Record of Decision for the Interim Remedial action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0343&D1, (ESD) was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act. This document provides the public the opportunity to understand the modifications to the remedial action for the Northwest Plume. As a result of the modifications, the remedial action scope is significantly different than that delineated in the *Record of Decision for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/06-1143&D4, (ROD) (DOE 1993). The 1993 ROD called for contaminated groundwater to be extracted at two locations. One was immediately north of the plant on the U.S. Department of Energy property and the second is off-site of the DOE property at the northern tip of the most contaminated portion of the plume. This ESD describes the discontinuation of groundwater extraction at the off-site location, which has been identified as a significant change from the action declared in the ROD.

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ACRONYMS

^{99}Tc	technetium-99
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulation*
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
EW	extraction well
FFA	Federal Facility Agreement
gpm	gallons per minute
HSWA	Hazardous and Solid Waste Amendment
IRA	interim remedial action
KAR	*Kentucky Administrative Regulation*
KEEC	Kentucky Energy and Environment Cabinet
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollution Discharge Elimination System
MW	monitoring well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NWP	Northwest Plume
O&M	operation and maintenance
PGDP	Paducah Gaseous Diffusion Plant
RGA	Regional Gravel Aquifer
ROD	Record of Decision
RSE	remedial system evaluation
TCE	trichloroethene
VOC	volatile organic compound

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) has prepared this Explanation of Significant Differences (ESD) to document the changes to the Record of Decision (ROD) for Interim Remedial Action (IRA) of the Northwest Plume (NWP) at the Paducah Gaseous Diffusion Plant necessary to optimize the existing NWP Groundwater System.

The ROD was signed by DOE, the U.S. Environmental Protection Agency (EPA), and the Kentucky Department for Environmental Protection (KDEP) in July 1993. The primary objective of the selected remedy, according to the ROD, was to "initiate a first phase remedial action, as an interim action to initiate control of the source and mitigate the spread of contamination in the Northwest plume." The selected remedy was designed to reduce the concentrations of trichloroethene (TCE) and technetium-99 (^{99}Tc) in the most contaminated portions of the NWP. Two extraction locations were defined in the ROD, the northern extraction well (EW) field and the southern EW field.

Additional reviews and assessments, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Reviews recommended modifications to the treatment system. This document explains the changes made during the optimization to the groundwater extraction wells, production rates, and the supporting components of the NWP Groundwater System. This optimization project did not result in modifications being made to the equipment utilized in contaminant removal in the treatment system.

The CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant documented the DOE commitment to modify the NWP IRA as recommended by the Remedial System Evaluation (RSE) Review Team (DOE 2009). The RSE Review Team recommended terminating the extraction at the two northern wells and increasing total extraction in the vicinity of the southern wells. According to the team, the change would increase contaminant mass removal and enhance capture near the southern EWs, which are closer to the contaminant sources.

The modification to the IRA of the Northwest Plume documented in this ESD is as follows:

- Termination of pumping at the existing northern EWs (EW228 and EW229) and taking the wells out of service (but they were not abandoned). [Pumping from the northern tip of the most contaminated portion of the plume—greater than 1000 ug/l of TCE—was identified in the ROD (DOE 1993).] Production capacity from the northern wells was moved to the southern well area.

Significant changes generally involve a change to a component of a remedy that does not fundamentally alter the overall cleanup approach (EPA 1999). The following modifications also were made to the material, equipment, and locations utilized in performing the optimization to the IRA but are deemed to be incidental changes, not changes to the IRA as documented in the ROD (DOE 1993):

- Termination of pumping at the existing southern EWs (EW230 and EW231) and placement of those wells in a stand-by condition;

- Installation and initiation of pumping from two new EWs (EW232 and EW233), located east of the original southern extraction field, at a combined actual maximum extraction rate of 220 gal per minute (gpm);

- Construction of water transfer pipes with leak detection monitoring equipment and tie-in to existing C-612 Treatment Facility;

- Construction of electrical service and pump-control wiring to the new EWs;

- Reassessment and selection of monitoring wells (MWs) to be utilized for chemical and hydraulic monitoring of the modified extraction system, which included installation of six additional monitoring wells; and

The modifications to the system did not create changes in the treatment system capacity, treatment levels, reliability, or cost of the overall remedy.

Groundwater modeling was used to identify and confirm the modifications that would be the most effective to increase contaminant mass removal. The modeling requires that limitations, constraints, and assumptions for the modeling be identified. The technical assumptions used in performing the optimization modeling resulted in confirming the following basic system parameters and modifications.

- The existing north EWs (EW228 and EW229) will be taken out of operation, but not abandoned.

- Pumping from the existing southern EWs (EW230 and EW231) will be stopped and the wells placed in a stand-by condition.

- Two new EWs will be installed in the southern well field closer to the contaminant sources.

- The EW field volumetric flow rate is limited by the current treatment plant capacity of approximately 220 gpm.

- No upgrades to the pump-and-treat facility to increase the treatment throughput.

- Effectiveness monitoring program consistent with the NWP ROD will be utilized as part of the NWP IRA Optimization. The wells to be utilized in effectiveness monitoring are existing MWs installed in the area of the IRA by other projects. New MWs were not installed by the NWP IRA Optimization project. The purpose of effectiveness monitoring is to create and maintain an adequate database on the hydrogeological situation in the NWP and to enable changes to be made in extraction rates and locations that will optimize remediation and system operation. Components of effectiveness monitoring include collection and assessment of hydraulic data and contaminant/chemical data.

In light of the new information identified and the modifications to the selected remedy, the remedy remains protective of human health and the environment and continues to comply with federal and state applicable or relevant and appropriate requirements (ARARS) that were identified at the time the original ROD was signed. The revised remedy also meets ARARs that have been identified as a result of this modification; these are discussed in Section 6, Statutory Determinations. A copy of this ESD has been placed in the Administrative Record file as stipulated by 40 *CFR* § 300.825(a)(2) and the DOE Environmental Repository along with the following supporting documents:

- Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant (DOE 2003);

- Paducah 2006 Sitewide Remedy Review (DOE 2006);

- Groundwater Remedial Systems Performance Optimization at PGDP (DOE 2007);

- Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant (DOE 2009); and

- Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization (DOE 2010).

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1. INTRODUCTION AND PURPOSE

The U.S. Department of Energy (DOE) is conducting cleanup activities at the Paducah Gaseous Diffusion Plant (PGDP) under its Environmental Management Program. Cleanup efforts are necessary to address contamination resulting from past waste-handling and disposal practices at the plant. The cleanup activities comply with the requirements of the U.S. Environmental Protection Agency (EPA), the Kentucky Energy and Environment Cabinet (KEEC), and DOE.

Pursuant to the Record of Decision (ROD) for Interim Remedial Action (IRA) of the Northwest Plume (NWP) at PGDP signed by DOE, EPA, and Kentucky Department for Environmental Protection (KDEP) in July 1993, DOE currently is operating groundwater extraction wells (EWs) and a treatment system at PGDP to control migration of the NWP. The treatment system is designed to remove trichloroethene (TCE) and technetium-99 (^{99}Tc) from extracted groundwater.

Reviews and assessments, including the Comprehensive Environmental Response, Compensation, and Liability Act-(CERCLA) mandated Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant documents (DOE 2003; DOE 2009), have resulted in recommended changes to the system to increase contaminant mass removal and enhance capture near the southern EWs, which are closer to the contaminant sources. Accordingly, DOE has prepared this Explanation of Significant Differences (ESD) to document the changes made to the NWP IRA that were necessary to optimize it.

1.1 SITE NAME AND LOCATION

PGDP is located in the northwestern corner of Kentucky in western McCracken County, about 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River (Figure 1). Past operations and disposal of waste material lead to the contamination of the groundwater migrating to the northwest from PGDP (Figure 2). Contaminated groundwater extends beyond the plant boundaries, with some discharge to surface waters downgradient, primarily Little Bayou Creek to the west and northeast of the DOE property boundaries, respectively. To date, the principal off-site risk is due to TCE, and the predominant source of TCE is south and southeast of Building C-400. Building C-400 is coincident with the highest TCE concentrations (i.e., the centroid) in the NWP (Figure 2). A source of ^{99}Tc contamination in groundwater is also in the C-400 area.

1.2 LEAD AND SUPPORT AGENCIES

DOE is the lead agency, and EPA and KEEC are the support agencies providing oversight.

In the fall of 1988, DOE and the EPA entered into an "Administrative Order by Consent" under Sections 104 and 106 of CERCLA to address the off-site contamination. On July 16, 1991, EPA and the Commonwealth of Kentucky (now KDEP) jointly issued permits under the Resource Conservation and Recovery Act, as amended by the Hazardous and Solid Waste Amendment (HSWA) of 1984. In May, 1992, the *Draft Interim Corrective Measure Work Plan For Hydraulic Containment and Ground Water Treatability Test* (Document # DOE-OR-1031) was submitted to EPA and KDEP, in accordance with the HSWA provisions of the KDEP and EPA permits, describing an option for initiating containment of the NWP. The ROD was signed by DOE, EPA, and KDEP in July 1993.

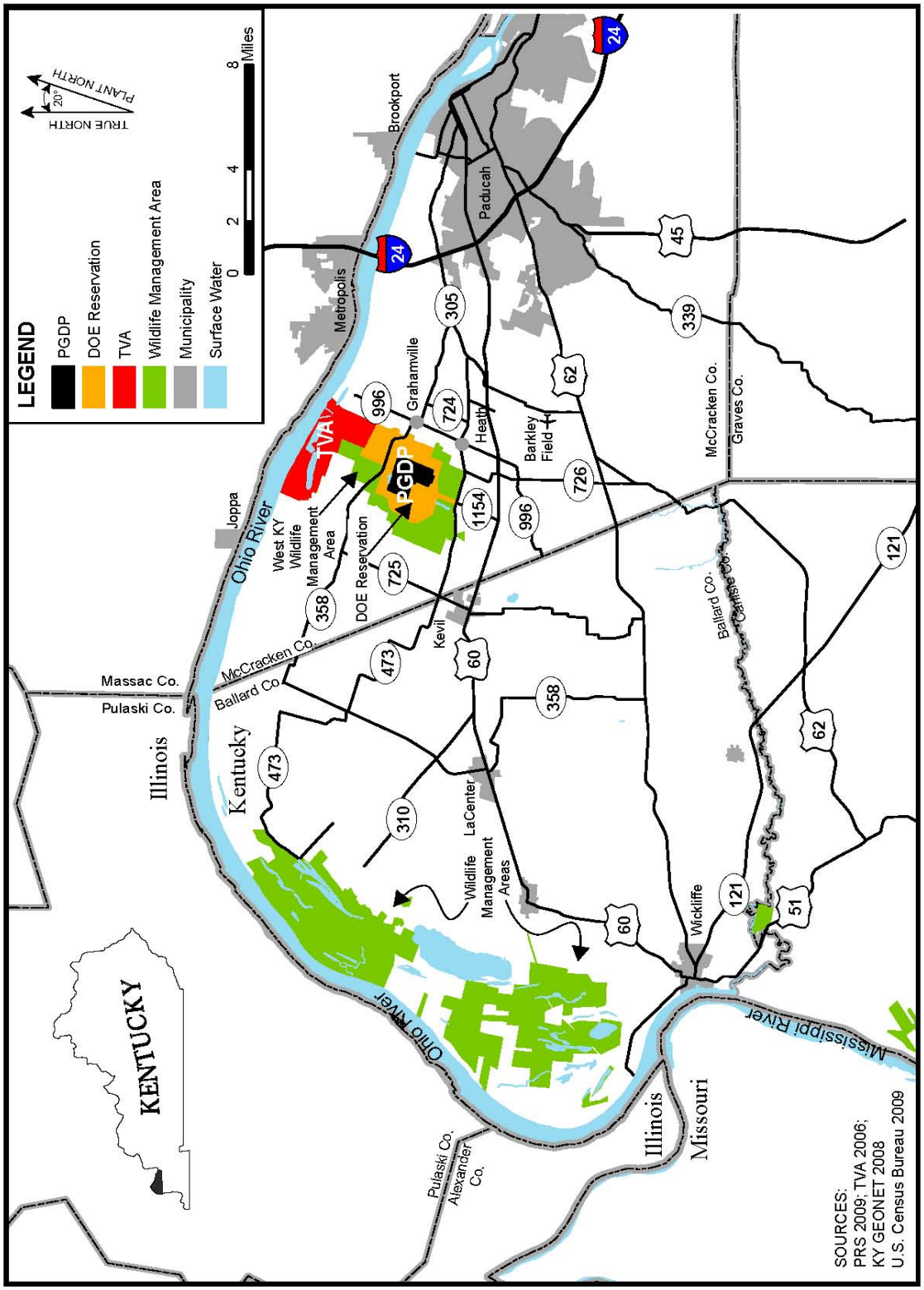

Figure 1. PGDP Location

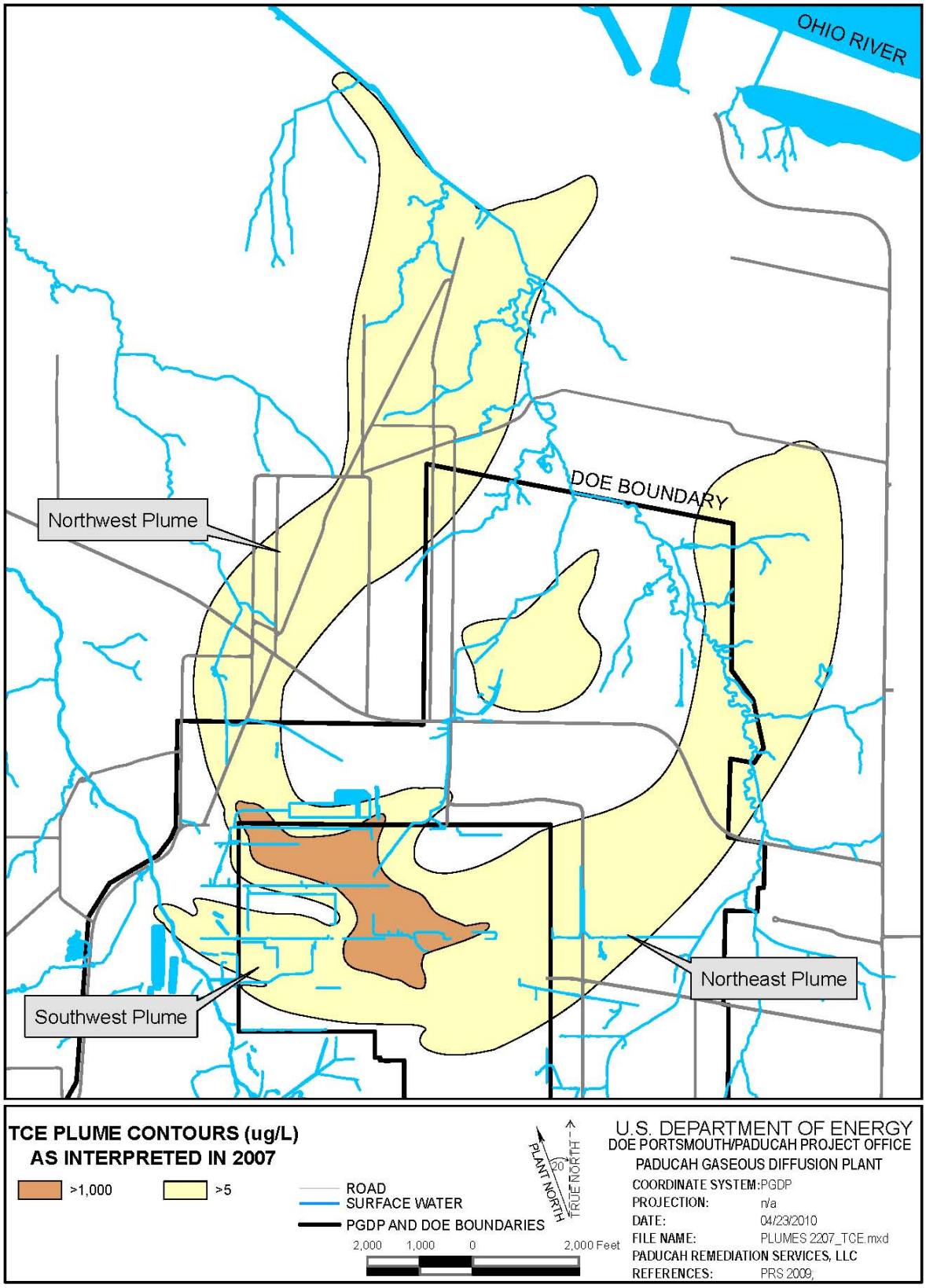

Figure 2. TCE Plumes at PGDP

In light of the new information identified and the modifications to the selected remedy, the remedy remains protective of human health and the environment and continues to comply with federal and state applicable or relevant and appropriate requirements (ARARs) that were identified at the time the original ROD was signed as well as additional ARARs discussed in Section 6. A copy of the ESD has been placed in the Administrative Record file as stipulated by 40 *CFR* § 300.825(a)(2) along with other associated documents utilized in performing the optimization.

PGDP was placed on the National Priorities List in 1994. Pursuant to Section 120 of CERCLA, the PGDP Federal Facility Agreement (FFA) (EPA 1998) was negotiated and implemented to coordinate the CERCLA remedial action and RCRA corrective action processes into a set of comprehensive requirements for site remediation. Since 1998, DOE, EPA, and KDEP have been operating under the FFA.

1.3 CERCLA AND NCP BACKGROUND

This ESD has been prepared in accordance with CERCLA Section 117(c) and 40 *CFR* § 300.435(c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 *CFR* § 300). The ESD is required when a significant change is made to the remedy defined in the decision document (e.g., ROD). A significant change generally involves a change to a component of a remedy that does not fundamentally alter the overall cleanup approach. This ESD describes the nature of the significant change, summarizes the information that led to making the change(s), and affirms that the revised remedy complies with the NCP and the statutory requirements of CERCLA. As required by 40 *CFR* § 300.435(c)(2)(i)(B), DOE will publish a notice of availability and a brief description of the ESD in a major local newspaper of general circulation. The ESD is made available to the public by placing it in the Administrative Record file and information repository (40 *CFR* §§ 300.435(c)(2)(i)(A) and 300.825(a)(2)).

1.4 CIRCUMSTANCES CREATING THE NEED FOR AN ESD

A CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant conducted in 2003 noted decreasing contaminant concentrations in the northern EWs and increasing concentrations in the southern EWs, potentially indicating that the high concentration core of the NWP (at the northern EW field) had migrated eastward and was bypassing the capture zone of the well field (DOE 2003). As a part of the recommendations and follow-up actions in the CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, an evaluation was recommended for the EW optimization at the NWP Groundwater System until a final remedy is determined. The optimization study was conducted in 2006 by a Remedial System Evaluation (RSE) Review Team. The final report recommended terminating extraction in the two wells in the north well field and increasing extraction in the south well field by a similar amount to increase contaminant mass removal (COE 2007). According to the RSE Review Team, the change would increase contaminant mass removal and enhance capture near the southern EWs, which are closer to the contaminant sources.

The CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant conducted in 2009 also acknowledged that effectiveness of the remedy could be improved by shutting off the pumps in the north field while increasing the pumping rate from the south well field. The Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant documented the DOE commitment to modify the NWP IRA Selected Remedy as recommended by the RSE Review Team (DOE 2009).

1.5 ADMINISTRATIVE RECORD FILE

As required by 40 *CFR* § 300.825(a)(2), this ESD will be made available to the public by placing it in the Administrative Record file. Contact information for the Administrative Record is as follows:

DOE Environmental Information Center
115 Memorial Drive, Barkley Centre
Paducah, KY 42001
(270) 554-6979
Fax; (270) 554-6987
info@pgdpcab.org

Hours of Operation: Monday through Friday
8 a.m.—12:00 p.m.

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2. SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY

This section provides a brief summary of the site contamination problems and history along with presenting the selected remedy as originally described in the ROD.

2.1 SITE HISTORY AND CONTAMINATION ASSOCIATED WITH THE NORTHWEST PLUME

In August 1988, volatile organic compounds (VOCs) and radionuclides were detected in private wells north of PGDP. The site investigation demonstrated that the principal contaminants of concern in the off-site groundwater are ^{99}Tc, a radionuclide, and TCE, an organic solvent. TCE is a flammable, highly volatile, colorless liquid used extensively for removing grease. The PGDP's use of TCE as a degreaser ceased July 1, 1993. Technetium-99 is a radionuclide that was introduced at the PGDP through the reprocessing of uranium.

Past handling practices and disposal of waste material lead to the contamination of the groundwater migrating to the northwest from PGDP. Studies of the NWP provide strong evidence that free-phase TCE is present as dense nonaqueous-phase liquid (DNAPL) in the vicinity of source areas in the Regional Gravel Aquifer (RGA). Over time, dissolved-phase TCE in groundwater in the RGA has spread generally northward toward the Ohio River in multiple plumes. In the 1993 time frame, the outer boundary of the plume was approximately three miles from the northern border of the facility security fence. The areal extent of the NWP was approximately 1.6 square miles, and it was assumed that approximately three billion gal of impacted groundwater are associated with the NWP. Concentrations of TCE within the NWP exceeded 1,000 ug/l in some locations.

DOE, EPA, and KDEP agreed that the presence and magnitude of TCE in the RGA necessitated an action to address the plume. The ROD was issued in 1993 and implementation of the Selected Remedy (pump-and-treat system) was completed in May of 1995.

Figure 2 illustrates the extent of the NWP and the two EW fields (north and south) installed for the NWP Groundwater System. Figures 3 and 4 provide a comparison of the TCE plumes between 1994 and 2007, (the latest available plume map). The downgradient limit of the NWP is near the Ohio River and at seeps in Little Bayou Creek.

2.2 INTERIM REMEDIAL ACTION REMEDY APPROVED IN THE ROD

The major components of the selected remedy defined in the ROD (DOE 1993) included the following:

- The contaminated groundwater will be extracted at two locations. The first location, immediately north of the plant on the 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 pg/l of 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 DNAPL or significantly affect other plumes. This pumping

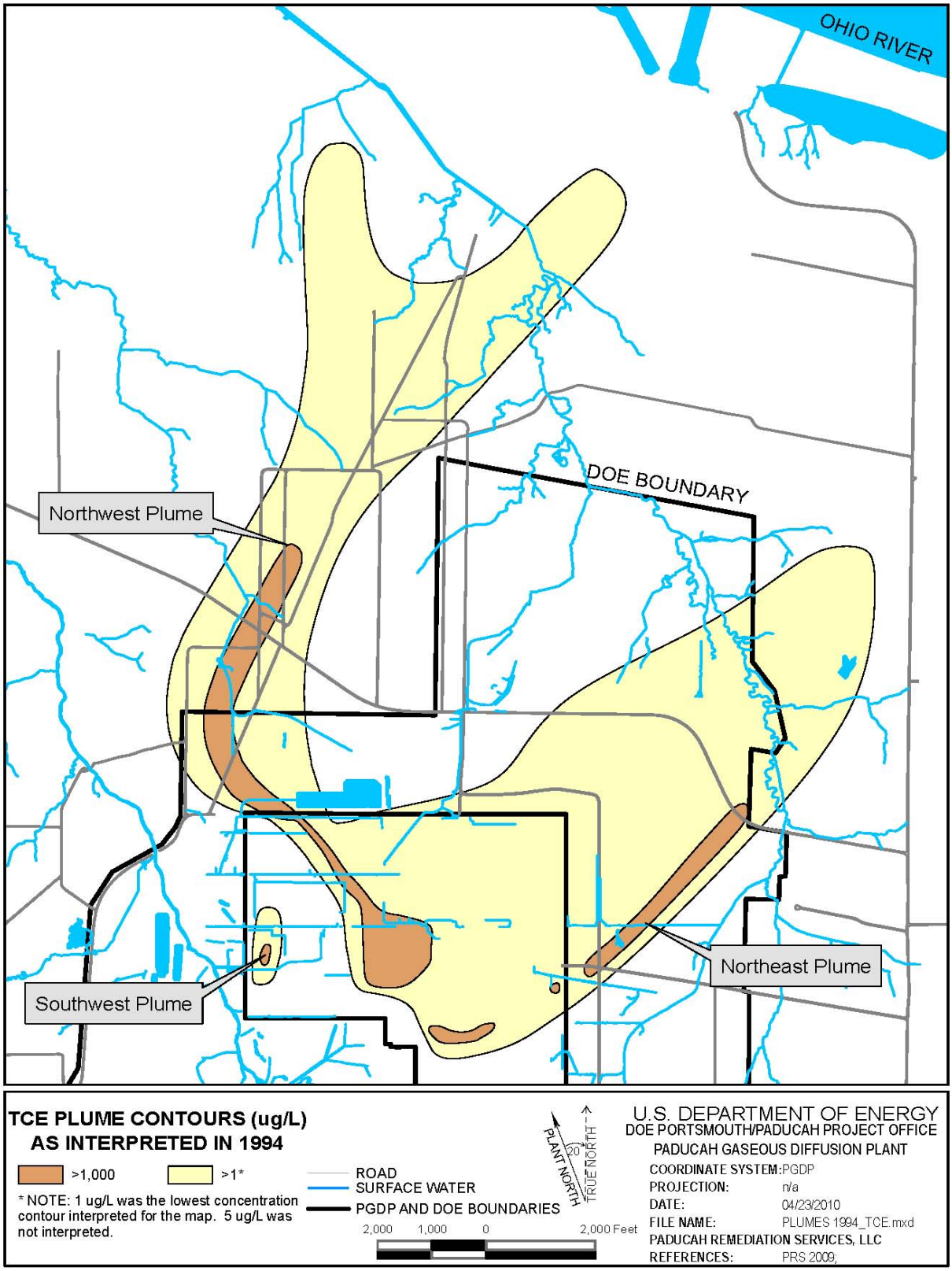

Figure 3. Extent of PGDP TCE Plumes—1994

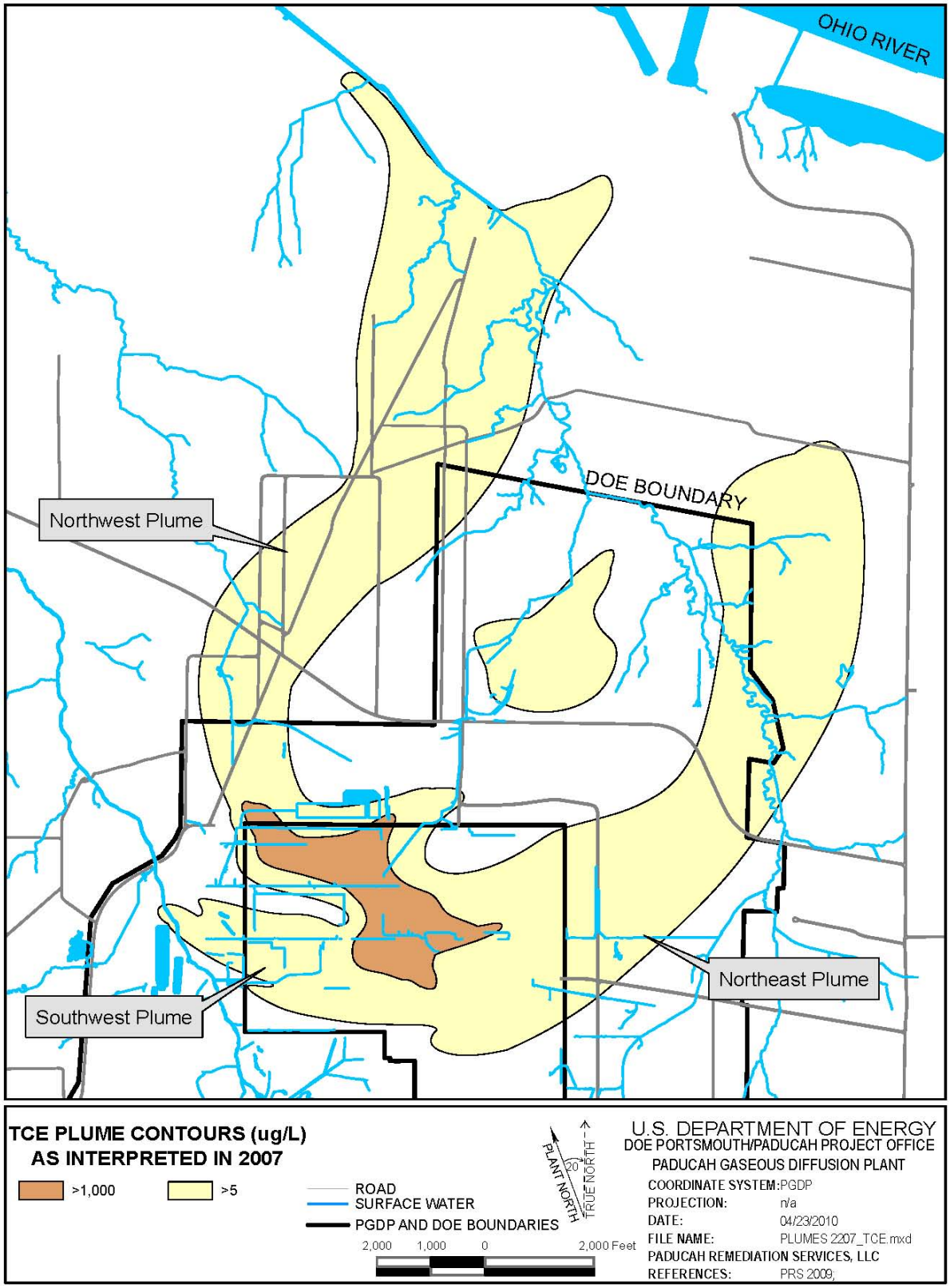

Figure 4. Extent of PGDP TCE Plumes—2007

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 is collected in a manifold and piped to the treatment system, which consists of two ion exchange units in parallel followed by an air stripper with treatment for off gas emissions. This technology will provide treatment to the contaminants of concern (TCE and ^{99}Tc). The target level for treatment of TCE is 5 ppb and 900 pCi/l for ^{99}Tc.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 Kentucky Pollutant Discharge Elimination System (KPDES) permitted Outfall 001.

- This interim action also includes implementation of a treatability study to evaluate an innovative technology. The innovative technology to be studied involves the potential utilizations 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.

System construction was completed in May 1995, with system testing and shakedown through August 27, 1995. The NWP Groundwater System began routine pump-and-treat operations on August 28, 1995. The remedial system, as installed, included the following:

- Four EWs and an associated monitoring well (MW) network, with two EWs located at the north end of the high-concentration zone and two EWs located immediately north of the plant (Figure 5).

- The transfer piping system from the EWs to the treatment plant is double-walled with leak detection.

- Treatment equipment located in the C-612 facility includes an equalization tank, a dual sand filter unit, a low-profile air stripper, two double ion-exchange units, and an on-line volatile organic analyzer.

- Support equipment installed in the C-612 facility includes a backwash system, settling tank, sludge handling equipment, an air compressor, and filter press.

In 1996 an ESD was prepared to modify the ROD. The modifications were related to the treatment system and included elimination of the activated carbon filters, reversal of the sequence of two treatment units (ion exchange unit and air stripper), and elimination of the iron filings treatability study. This ESD is available in the Administrative Record (DOE 1996).

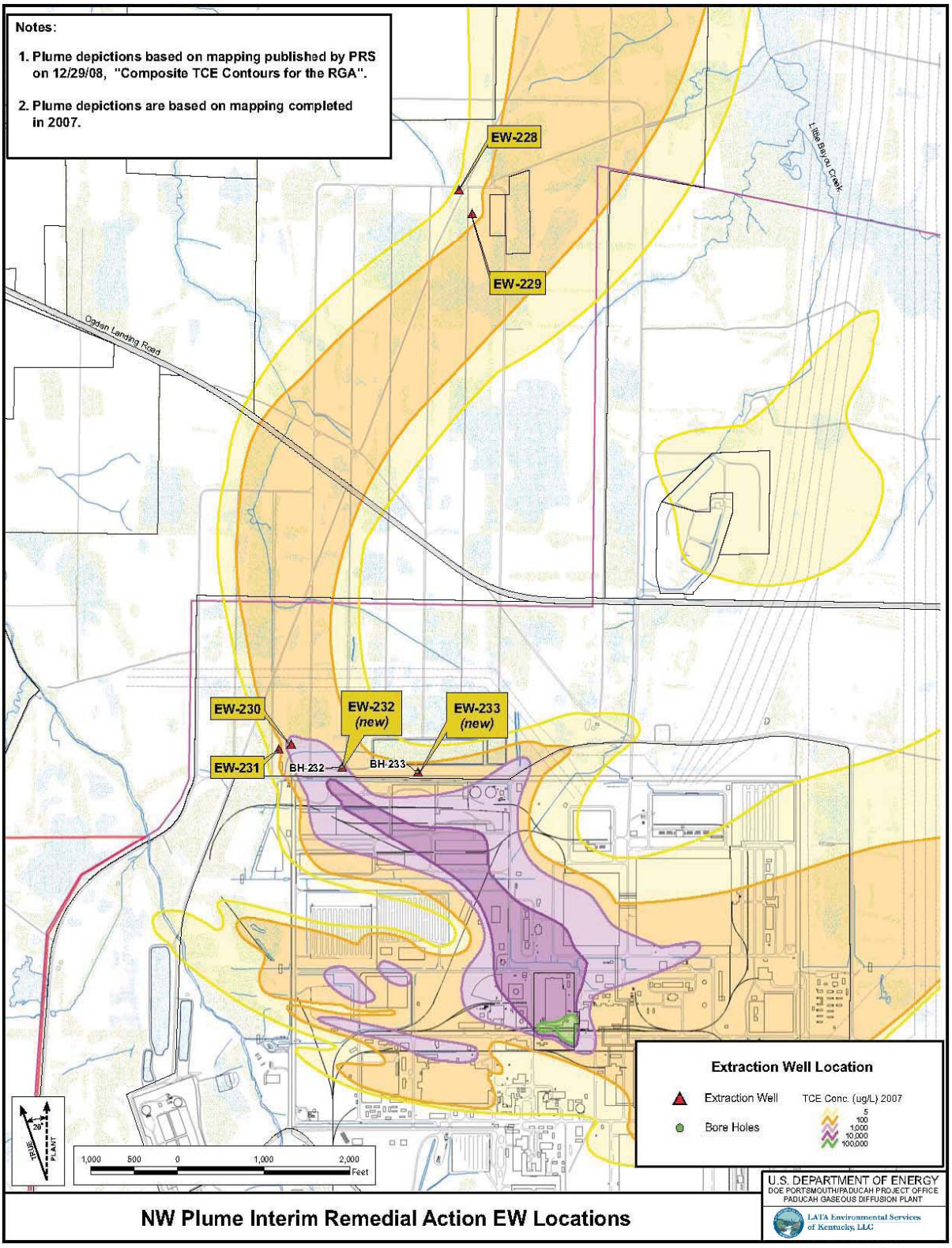

Figure 5. Location Two New EWs (EW232 and EW233) in Southern Well Field

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3. BASIS FOR THE ESD

This section provides the information that prompted and supports changes to the remedy and provides reference information in the Administrative Record that supports the need for the change.

3.1 INFORMATION SUPPORTING THE SIGNIFICANT DIFFERENCES

Four evaluations have been conducted that support the proposed changes to the NWP Groundwater System. In 2003, DOE first noted that well optimization should be evaluated to determine if extraction from the system could be made more effective. Summary of the evaluation and relevant findings for these four evaluations are detailed in this section.

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

The CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant for 2003 was published in October 2003 (DOE 2003). In it the assessors observed that "persistent contaminant levels of approximately 100 µg/L TCE and 100 pCi/L ^{99}Tc in water samples from the east down gradient MW indicates that some dissolved contamination is bypassing the south EW Field. Moreover, 2002 contaminant level trends suggest that the high-concentration core of the NWP has persisted in migrating eastward and is now significantly bypassing the capture zone of the north EW Field." In the 2003 review, the assessors recommended that the EW field be evaluated for possible optimization.

3.1.2 Sitewide Remedy Review

In February and March 2006, DOE conducted a Sitewide Remedy Review at PGDP. Recommendations in the Sitewide Remedy Review Report (DOE 2006) corroborated the recommendations and follow-up actions of the 2003 CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant report. The report specifically recommended evaluation of EW optimization for the NWP pump-and-treat system. One reason given for this follow-up action is that the high concentration core of the NWP (at the north EW field) has migrated eastward and is bypassing the capture zone of the well field. The Review Team noted that it is consistent with the ROD and the 2003 CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant findings to modify the remedy in order to provide more cost-effective capture of the plumes.

3.1.3 Remedial Technology Review

At the request of the DOE Headquarters Office of Environmental Management, the Office of Groundwater and Soil Remediation secured the services of the U.S. Army Corps of Engineers to lead a RSE of the Northeast and Northwest Extraction Systems at the PGDP during October 2006.

The RSE Review Team recommended terminating the extraction at the two northern EWs of the NWP Groundwater System, and increasing total extraction in the vicinity of the southern EWs by a similar amount (COE 2007). Additionally, the team suggested that there was no reason to permanently dismantle the wells, but rather recommended only to terminate pumping from those wells. The design modification recommended would not require an increase in the capacity of the existing treatment plant according to the team recommendations.

These are the strategies recommended for increasing extraction in the vicinity of the southern wells.

- Increasing extraction at existing southern wells.

- Adding additional extraction locations near the southern well field.

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

The CERCLA Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant report (DOE 2009) acknowledged that the IRA was reducing contaminant concentrations in the NWP, but could be more effective by shutting off the pumps in the northern field while increasing the pumping rate from the southern well field. The primary concern expressed in the report with regard to the EW fields was the extent of the zones of capture. Hydrogeological information reviewed by the author(s) indicated that optimization of the extraction systems was likely warranted, and the author(s) acknowledged that a path forward was being pursued among the FFA parties.

This Five-Year Review Report documented the DOE commitment to modify the NWP IRA as recommended by the RSE Review Team. The RSE Review Team recommended terminating the extraction at the two northern wells and increasing total extraction in the vicinity of the southern wells. According to the team, the change would increase contaminant mass removal and enhance capture near the southern EWs, which are closer to the contaminant sources.

3.1.5 Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization

The Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization documents the design and construction process associated with the optimization process (DOE 2010). Detail information is included concerning the use of the PGDP groundwater model to optimize the locations of the extraction wells for contaminant capture, monitoring wells locations for hydraulic and chemical monitoring, extraction well construction including screen size and locations. Following the approval of the Remedial Action Work Plan, field construction activities began in June 2010 and were completed in August 2010.

3.2 ADMINISTRATIVE RECORD INFORMATION SUPPORTING THE NEEDED CHANGE

Information contained in the administrative record that supports the needed change is discussed in Section 3.1.

4. DESCRIPTION OF SIGNIFICANT DIFFERENCES

This section describes the significant differences between the remedy in the ROD and the ESD modifications, highlighting scope, cost, and performance along with any changes in expected outcomes when the modifications are implemented.

4.1 SIGNIFICANT DIFFERENCES BETWEEN THE REMEDY AND ESD MODIFICATIONS

Table 1 summarizes the main components of the selected remedy and identifies how the remedy modification impacts these components.

Table 1. Summary of Modifications to the Selected Remedy

Selected Remedy in the ROD	Remedy Modification
The contaminated groundwater is extracted at two locations. The first location, immediately north of the plant on the 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 pg/l of 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 DNAPL or significantly affecting other plumes. This pumping rate may be modified during operation to optimize hydraulic containment by adjusting flow from the EWs and to support subsequent actions. Source remediation is not addressed by the selected remedy; however, it will address the continue release from a DNAPL as a principal threat source area.	The optimized remedy modifies the selected remedy terminating pumping at the EWs at the northern part of the plume. . Contaminant mass extraction immediately north of the plant (south well field) is further optimized with the installation of two new EWs and associated piping, instrumentation and controls. The new extraction wells comprise additional system components that operate within the current through-put capacity of the existing treatment process equipment. The overall actual pumping rate is approximately 220 gal per minute. Pumping from the existing southern EWs has stopped and the wells placed in a stand-by mode.
The extracted groundwater is collected in a manifold and piped to the treatment system, which consists of two ion exchange units in parallel, followed by an air stripper with treatment for off-gas emissions. This technology provides treatment to the contaminants of concern (TCE and ^{99}Tc). The target level for treatment of TCE is ***5*** ppb and 900 pCi/l for ^{99}Tc. The amount of treated water discharged will be limited by the flow capacity of the skid mounted treatment units. The treated water is discharged through KDEPS-permitted Outfall 001. The treatment system was modified by the 1996 ESD; the order of the air stripper and ion exchange units was reversed.	No change has occurred to the current configuration of the treatment system.

Table 1. Summary of Modifications to the Selected Remedy (Continued)

Selected Remedy in the ROD	Remedy Modification
Although the 1996 ESD also allowed the elimination of activated carbon filters for vapor-phased contaminant treatment, DOE has continued their use.	
The amount of treated water discharged is limited by the flow capacity of the skid mounted treatment units. The treated water is discharged through KPDES permitted Outfall 001.	No change for the discharge.
This interim action also includes implementation of a treatability study to evaluate an innovative technology. The innovative technology to be studied involves the potential utilizations of iron filings as a viable alternative to pump-and-treat technology for groundwater treatment. The requirement for a treatability study was eliminated by the 1996 ESD.	No change.

DOE = U.S. Department of Energy
DNAPL = dense nonaqueous-phase liquid
ESD = explanation of significant differences
EW = extraction well
IRA = interim remedial action
KPDES = Kentucky Department for Environmental Protection
NWP = northwest plume
ROD = Record of Decision
TCE = trichloroethene

4.2 EXPECTED OUTCOMES OF THE ESD

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 well field located immediately north of the plant. The key components to effecting optimization are discontinuing the use of the four existing EWs and replacing those wells with two new extraction wells located east of the existing southern well field. The changes made to the system did not create changes in the treatment system operation and volumetric capacity, treatment levels, reliability, or cost of the overall remedy.

4.2.1 Optimization Modeling Approach and Assumptions

Optimization modeling was performed in late 2009 under the following requirements and assumptions to assess the potential for optimization of the south well field in accordance with the Five-Year Review Report (DOE 2009). The optimization effort was undertaken utilizing the updated PGDP groundwater flow model coupled with the *Brute Force* particle tracking software (Laase *et al*. 1999). Requirements and limitations of the modeling included a maximum theoretical treatment volume of 250 gpm, EWs located near the north fence of PGDP, and contaminant distribution was based on NWP concentrations. Simulations utilizing one, two, three, or four EWs at various locations were performed to determine the best contaminant capture configuration. The simulations identified the two-well configuration to be the most effective on contaminant capture at 99.99% when no anthropogenic recharge is present. The two-well simulations then were run with the actual treatment volume of 220 gpm for the treatment system and identified that contaminant mass capture was 99.87% and 99.97% for anthropogenic recharge and no anthropogenic recharge, respectively. The results of the modeling identified the two-EW system as identified in Figure 5.

4.2.2 Key Design Changes

The NWP IRA optimization was designed based on the following key changes and assumptions which are different from that documented in the ROD (DOE 1993):

- The existing north EWs (EW228 and EW229) were shut down and taken out of service.
- The existing north EWs, EW228 and EW229, will not be abandoned at this time, but they will not be operational.

4.2.3 Key Design Assumptions

The NWP IRA optimization was designed based on the following key assumptions:

- The existing south EWs, EW230 and EW231, are out of service, but will remain in standby mode, to be made operational with minimal effort, and will be replaced by two new EWs located east of the EW230 location.
- The EW field volumetric flow rate is limited by the current actual treatment plant capacity (approximately 220 gpm).
- No upgrades are planned for the pump-and-treat facility to increase the treatment throughput.
- The design and placement of the two new EWs (EW232, EW233) were based on modeling results and on geotechnical data (grain size analyses and lithologic logs) gathered from boreholes installed in close proximity to the proposed well locations.
- Pumping tests were not performed as a basis for design of the new EWs. Existing pumping test information, lithologic logs from pilot borings, and grain size data from pilot boring samples was evaluated as a basis of design for these wells.
- Electrical power is provided from existing feeder lines supplying power to the C-612 treatment facility and the existing south EWs.
- No wetlands were impacted as a result of the new EWs.

4.2.4 Well Field Design

Well field optimization modeling indicates that a two-well configuration is optimal. The two new wells, EW232 and EW233, are located north of the fence line at the northwest corner of PGDP. Refer to Figure 5 for well locations. The EWs have a design capacity 220 gpm each, as allowable by the formation. Boreholes were installed approximately 10 to 12 ft from the proposed locations for the two new EWs. Detailed lithologic logs and grain size analysis was used in well screen and filter pack design.

4.2.5 Construction

Mechanical and electrical design and construction were compatible with the current NWP IRA system. Materials of construction were appropriate for conditions associated with the NWP IRA system. The transfer pipeline was dual-wall and passed through manholes configured with leak detection. The transfer line for the new wells tied into an existing manhole on the east side of the C-612 Facility. As indicated in the Key Design Assumptions section, the existing north wells, EW228 and EW229, will be taken out of

operation. Instrumentation and control logic for EW228 and EW229 was changed at the C-612 programmable logic controller thereby making them inoperable without additional effort. Minor mechanical, electrical, and instrumentation/control changes affecting the existing south wells, EW230 and EW231, were performed allowing them to be put back into service quickly.

4.2.6 Start Up and Testing

The NWP IRA System was off-line for an estimated 16 days to allow for final connections and construction acceptance testing activities. Intermittent shut downs were required during integrated testing of the new wells and system control logic. The start up and testing plan was to be documented in a revision to the Operation and Maintenance Plan (O&M).

4.2.7 Operation and Maintenance

Successful completion of the integrated testing of the new wells has allowed the new EWs to routinely operate at approximately 110 gpm each. Ongoing O&M will continue to be performed in accordance with the revised O&M Plan and operating procedures. EPA and KY reviewed the revisions to the O&M Plan prior to start up of the new wells for routine operations.

4.2.8 Effectiveness Monitoring

An effectiveness monitoring program consistent with the NWP ROD was redesigned and installed as part of the NWP IRA Optimization. The purpose of system effectiveness monitoring is to create and maintain an adequate database on the hydrogeological situation in the NWP and to enable changes to be made in extraction/injection that will optimize remediation and containment (DOE 1993). Components of effectiveness monitoring include collection and assessment of hydraulic data and contaminant data.

4.2.9 Waste Management And Disposition

Waste generated during drilling and construction activities was managed and dispositioned in accordance with the project waste management plan and ARARs.

4.2.10 Remedial Action Work Plan

A Remedial Action Work Plan was developed for the implementation of the remedy modifications based on the above assumptions and expected outcomes. The Remedial Action Work Plan included an overview of the optimization modeling, system design and construction, startup and testing, operations and maintenance requirements, and plans for effectiveness monitoring, environmental compliance, waste management, worker health and safety, quality assurance, and data management. The document was reviewed and approved by EPA and the Commonwealth of Kentucky on May 10, 2010, and June 3, 2010, respectively, allowing the optimization process to proceed.

5. SUPPORT AGENCY COMMENTS

This section will include support agency comments.

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6. STATUTORY DETERMINATIONS

In light of the new information identified and the modifications to the selected remedy, the remedy remains protective of human health and the environment and continues to comply with federal and state ARARs that were identified at the time the original ROD was signed. The revised remedy also meets ARARs that are identified in Table 2 of this ESD. Table 2 identifies these additional ARARs that have been triggered due to the well drilling required to implement the remedy modifications. The revised remedy is cost-effective and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site.

Table 2. Additional Applicable or Relevant and Appropriate Requirements

Action	Requirements	Prerequisite	Citation
Monitoring well installation	Permanent monitoring wells shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for remedial action—**applicable**.	401 *KAR* 6:350 §1(2)
	All permanent monitoring wells (including boreholes) shall be constructed to comply with the substantive requirements provided in the following Sections of 401 *KAR* 6:350: • Section 2. Design Factors; • Section 3. Monitoring Well Construction; • Section 7. Materials for Monitoring Wells; and • Section 8. Surface Completion.		401 *KAR* 6:350 § 2, 3, 7, and 8
	If conditions exist or are believed to exist that preclude compliance with the requirements of 401 *KAR* 6:350, may request a variance prior to well construction or well abandonment. *NOTE: Variance shall be made as part of the FFA CERCLA document review and approval process and shall include:* • A justification for the variance; and • Proposed construction, modification, or abandonment procedures to be used in lieu of compliance with 401 *KAR* 6:350 and an explanation as to how the alternate well construction procedures ensure the protection of the quality of the groundwater and the protection of public health and safety.		401 *KAR* 6:350 § 6 (a)(6) and (7)
Development of monitoring well	Newly installed wells shall be developed until the column of water in the well is free of visible sediment. This well-development protocol shall not be used as a method for purging prior to water quality sampling.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for remedial action—**applicable**.	401 *KAR* 6:350 §9
Direct Push monitoring well installation	Wells installed using direct push technology shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of direct push monitoring well as defined in 401 *KAR* 6:001 §1(18) for remedial action—**applicable**.	401 *KAR* 6:350 §5 (1)

Table 2. Additional Applicable or Relevant and Appropriate Requirements (Continued)

Action	Requirements	Prerequisite	Citation
	Shall also comply with the following additional standards: (a) The outside diameter of the borehole shall be a minimum of 1 inch greater than the outside diameter of the well casing; (b) Premixed bentonite slurry or bentonite chips with a minimum of one-eighth (1/8) diameter shall be used in the sealed interval below the static water level; and (c) 1. Direct push wells shall not be constructed through more than one water-bearing formation unless the upper water bearing zone is isolated by temporary or permanent casing. 2. The direct push tool string may serve as the temporary casing.		401 *KAR* 6:350 §5 (3)
Monitoring well abandonment	A monitoring well that has been damaged or is otherwise unsuitable for use as a monitoring well, shall be abandoned within 30 days from the last sampling date or 30 days from the date it is determined that the well is no longer suitable for its intended use.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for remedial action—**applicable**.	401 *KAR* 6:350 §11 (1)
	Wells shall be abandoned in such a manner as to prevent the migration of surface water or contaminants to the subsurface and to prevent migration of contaminants among water bearing zones.		401 *KAR* 6:350 §11 (1)(a)
	Abandonment methods and sealing materials for all types of monitoring wells provided in subparagraphs (a)-(b) and (d)-(e) shall be followed.		401 *KAR* 6:350 §11 (2)
Extraction well installation	Wells shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of extraction well for remedial action—**relevant and appropriate**.	401 *KAR* 6:350 §1 (2)

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7. PUBLIC PARTICIPATION REQUIREMENTS

Community involvement is a critical aspect of the cleanup process at the PGDP. The DOE encourages the public to review this ESD. As required by 40 *CFR* § 300.435(c)(2)(i), a Notice Availability and brief description of this ESD will be published in the local newspaper announcing the availability of the ESD for review in the Administrative Record file as required by the NCP (40 *CFR* §§ 300.435(c)(2)(i)(A) and 300.825(a)(2)). The Administrative Record File that contains the ROD, 1996 ESD, and the CERCLA Five-Year Reviews and other associated documentation is available for review at the following:

DOE Environmental Information Center
115 Memorial Drive, Barkley Centre
Paducah, KY 42001
(270) 554-6979
Fax; (270) 554-6987
info@pgdpcab.org

Hours of Operation: Monday through Friday
8 a.m.—12:00 p.m.

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8. APPROVALS

Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

DOE/LX/07-0343&D1

September 2010

William Murphie, Manager
Portsmouth and Paducah Project Office
U.S. Department of Energy

9/30/10
Date

Franklin E. Hill, Director
Superfund Division
U.S. Environmental Protection Agency – Region 4

Date

Tony Hatton, Director
Division of Waste Management
Kentucky Department for Environmental Protection

Date

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9. REFERENCES

COE (U.S. Army Corps of Engineers) 2007. *Review Report: Groundwater Remedial System Performance Optimization at PGDP, Paducah, Kentucky,* U.S. Army Corps of Engineers, Nashville, TN, May.

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Laase, A. D., J. O. Rumbaugh III, E. R. Anderman and J. B. Baker. 1999. *Application of Economic-Risk Analysis for Design and Optimization of the Kansas City Plant Interceptor System*, in the proceedings from ModelCare 99: Calibration and Reliability in Groundwater Modeling conference, Zurich, Switzerland.

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