**Department of Energy**

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JUL 22 2011

PPPO-02- 1172300-11B

Ms. Jennifer Tufts
U.S. Environmental Protection Agency, Region 4
Federal Facilities Branch
61 Forsyth Street
Atlanta, Georgia 30303

Mr. Edward Winner, FFA Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Tufts and Mr. Winner:

**TRANSMITTAL OF THE D1 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&D1)**

Enclosed for your review is the certified D1 *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&D1.

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

Sincerely,

Reinhard Knerr
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. D1 ROD for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the SW Groundwater Plume DOE/LX/07-0365&D1

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# CERTIFICATION

**Document Identification:** ***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&D1, Primary Document**

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

Paducah Remediation Services, LLC
Operator

Mark J. Duff, Paducah Project Manager — 7-22-11
Date Signed

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

U.S. Department of Energy (DOE)
Owner

William E. Murphie, Manager
Portsmouth/Paducah Project Office — 7/22/11
Date Signed

DOE/LX/07-0365&D1
Primary Document

# 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

**CLEARED FOR PUBLIC RELEASE**

**DOE/LX/07-0365&D1**
**Primary Document**

# 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

Date Issued—July 2011

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

**CLEARED FOR PUBLIC RELEASE**

# PREFACE

The *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0365&D1, was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act, Resource Conservation and Recovery Act; *KRS* 224.46-530; and the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707 (EPA 1998).

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# CONTENTS

# TABLES

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# FIGURES

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# ACRONYMS

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|---|---|
| 1,1-DCE | 1,1-dichloroethene |
| ACO | Administrative Order by Consent |
| AR | Administrative Record |
| ARAR | applicable or relevant and appropriate requirement |
| BHHRA | baseline human health risk assessment |
| CDI | chronic daily intake |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| *CFR* | *Code of Federal Regulations* |
| *cis*-1,2-DCE | *cis*-1,2-dichloroethene |
| COC | contaminant of concern |
| COPC | chemical of potential concern |
| CSM | Conceptual Site Model |
| CSOU | Comprehensive Site Operable Unit |
| DCE | dichloroethene |
| D&D | decontamination and decommissioning |
| DNAPL | dense nonaqueous-phase liquid |
| DOE | U.S. Department of Energy |
| DPT | direct push technology |
| EISB | enhanced *in situ* bioremediation |
| ELCR | excess lifetime cancer risk |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| E/PP | excavation/penetration permit |
| ERH | electrical resistance heating |
| FC | final characterization |
| FFA | Federal Facility Agreement |
| FFS | focused feasibility study |
| FS | feasibility study |
| GAC | granular-activated carbon |
| GDP | gaseous diffusion plant |
| GI | gastrointestinal |
| HEAST | Health Effects Assessment Summary Tables |
| HI | hazard index |
| HQ | hazard quotient |
| IRIS | Integrated Risk Information System |
| KDEP | Kentucky Department for Environmental Protection |
| LAI | liquid atomized injection |
| LDA | large-diameter auger |
| LUC | land use control |
| MCL | maximum contaminant level |
| MIP | membrane interface probe |
| NCEA | National Center for Environmental Assessment |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NEPA | National Environmental Policy Act |
| NPL | National Priorities List |
| NR | no modeling results available |
| NV | no value |
| O&M | operation and maintenance |

| | |
|---|---|
| OU | operable unit |
| ORP | oxidation reduction potential |
| PCB | polychlorinated biphenyl |
| PGDP | Paducah Gaseous Diffusion Plant |
| POE | point of exposure |
| PP | proposed plan |
| PPE | personal protective equipment |
| PTSM | principal threat source material |
| PTW | principal threat waste |
| RA | Removal Action |
| RAO | remedial action objective |
| RAWP | Remedial Action Work Plan |
| RCRA | Resource Conservation and Recovery Act |
| RD | Remedial Design |
| RDSI | Remedial Design Support Investigation |
| Rfd | reference dose |
| RG | remediation goal |
| RGA | Regional Gravel Aquifer |
| RI | remedial investigation |
| RME | reasonable maximum exposure |
| ROD | Record of Decision |
| SF | slope factor |
| SI | site investigation |
| SMP | Site Management Plan |
| SWMU | solid waste management unit |
| TCA | trichloroethane |
| TCE | trichloroethene |
| *trans*-1,2-DCE | *trans*-1,2-dichloroethene |
| UCRS | Upper Continental Recharge System |
| VC | vinyl chloride |
| VOC | volatile organic compound |
| WAG | waste area grouping |

# PART 1

# DECLARATION

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# PART 1. DECLARATION FOR RECORD OF DECISION FOR SOLID WASTE MANAGEMENT UNITS 1, 211-A, 211-B, AND PART OF 102 (C-747-C OIL LANDFARM AND C-720 NORTHEAST AND SOUTHEAST SITES) FOR THE SOUTHWEST GROUNDWATER PLUME AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

## 1.1 SITE NAME AND LOCATION

Southwest Groundwater Plume Volatile Organic Compound Sources
- C-747-C Oil Landfarm—Solid Waste Management Unit 1
- C-720 Building Northeast Site—Solid Waste Management Unit 211-A
- C-720 Building Southeast Site—Solid Waste Management Unit 211-B
- Plant Storm Sewer (Partial)—Part of Solid Waste Management Unit 102

Groundwater Operable Unit
Paducah Gaseous Diffusion Plant
Paducah, Kentucky
EPA ID—KY 8-890-008-982

## 1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedies for the Groundwater Operable Unit (OU) Southwest Groundwater Plume volatile organic compound (VOC) sources (C-747-C Oil Landfarm, C-720 Northeast and Southeast Sites, and Plant Storm Sewer), comprised primarily of trichloroethene (TCE), at the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky, and includes discussion of the contribution that this remedial action will make toward the final decision for the Groundwater OU at PGDP. This remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 and, to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record (AR) file for this site.

In addition, this decision document has been prepared in accordance with paragraph II E.2 of the *Secretarial Policy Statement on the National Environmental Policy Act* (NEPA) (DOE 1994), which states, "To facilitate meeting the environmental objectives of CERCLA and to respond to concerns of regulators, consistent with the procedures of most other Federal agencies, the U.S. Department of Energy (DOE) hereafter will rely on the CERCLA process for review of actions to be taken under CERCLA and will address NEPA values and public involvement procedures as provided below. Department of Energy CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable."

A Revised Focused Feasibility Study (FFS) for the Southwest Groundwater Plume VOC sources was developed and submitted to the U.S. Environmental Protection Agency (EPA) and Commonwealth of Kentucky on May 12, 2011 (DOE 2011a). The Revised FFS was approved by EPA, and the Commonwealth of Kentucky on May 18, 2011 The FFS specifically evaluated alternatives for Solid Waste Management Unit (SWMU) 1, (C-747-C Oil Landfarm) and C-720 Northeast (SWMU 211-A) and

Southeast (SWMU 211-B) Sites (DOE 2011a). This action also is supported by the Feasibility Study for the Groundwater OU (FS) developed in 2001 and approved by the EPA and Commonwealth of Kentucky. The Proposed Plan (PP) for the TCE sources to the Southwest Plume (SWMU 1, C-720 Northeast and Southeast Sites, and Part of SWMU 102) (DOE 2011b) was submitted to the EPA and Commonwealth of Kentucky on June 22, 2011. After approval of the PP by EPA and the Commonwealth of Kentucky, a notice of availability of the PP was published in *The Paducah Sun* on TBD, and a public comment period was held from TBD to TBD. The Commonwealth of Kentucky concurs with the remedial action for TCE contamination at the SWMU 1 (C-747-C Oil Landfarm) and C-720 Northeast (SWMU 211-A) and Southeast (SWMU 211-B) Sites selected in this document by DOE and EPA and with the contribution this remedial action will make toward the final decision for the Groundwater OU. Risks posed by direct contact with contaminated surface soil or sediment at the C-747-C Oil Landfarm and C-720 Building area or remaining risks from potential use of contaminated groundwater from non-VOC contaminants will be addressed later as part of the decisions for the Soils OU and Groundwater OU. Also, the Commonwealth of Kentucky concurs with DOE and EPA that no further action is necessary and is appropriate at the evaluated Plant Storm Sewer because the site is not a source of groundwater contamination.

## 1.3 ASSESSMENT OF THE SITE

DOE conducted a Site Investigation (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)]. Of the four areas investigated, the SI identified the C-720 Northeast and Southeast Sites and SWMU 1 as probable groundwater contributors to TCE groundwater contamination in the Southwest Plume. The areas also were investigated previously as part of the Waste Area Grouping (WAG) 27 Remedial Investigation (RI) [*Remedial Investigation Report for the Waste Area Grouping 27 at the Paducah Gaseous Diffusion Plant Paducah, Kentucky* (DOE 1999a)].

At SWMU 1 (C-747-C Oil Landfarm), TCE was detected in 71 analyses with concentrations ranging from below detection up to 439 mg/kg. The TCE concentrations within the source zone vary from 5.74 mg/kg at 15.2 to 16.8 m (50 to 55 ft) deep to 110.8 mg/kg at 3.0 to 6.1 m (10 to 20 ft) deep. The estimated total TCE remaining in the soils of the C-747-C Oil Landfarm source zone was approximately 187 L (49 gal).

At the C-720 Northeast and Southeast Sites, TCE concentrations were detected in a range of 0.10 mg/kg at 15.2 to 18.4 m (50 to 60 ft) deep to 11.9 mg/kg at 6.1 to 9.2 m (20 to 30 ft) deep. The estimated total TCE remaining in the soils of Northeast and Southeast source zones was approximately 76 L (20 gal).

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment from the source zone comprised of TCE and other VOCs at the C-747-C Oil Landfarm and C-720 Northeast and Southeast Sites (SWMUs 211-A and 211-B). The portion of the Plant Storm Sewer site investigated is not a source of groundwater contamination; therefore, no further action is necessary.

## 1.4 DESCRIPTION OF SELECTED REMEDIES

At PGDP, site cleanup includes a series of prioritized response actions, which are coordinated with the PGDP Strategic Cleanup Initiatives. To achieve these initiatives, DOE and the regulatory agencies have agreed to use five media-specific OUs to evaluate and implement response actions. These five OUs, which include response actions in the near- and intermediate-term that will be completed without disrupting ongoing uranium enrichment plant operations, are as follows (DOE 2011c):

- Burial Grounds OU,
- Decontamination and Decommissioning (D&D) OU,
- Groundwater OU,
- Soils OU, and
- Surface Water OU.

In addition to the response actions, each OU includes site characterization activities to support future response action decisions.

Once the gaseous diffusion plant (GDP) ceases operation and a decision has been made to proceed with D&D of the plant, a series of post-GDP shutdown activities will be implemented. These D&D activities will be followed by the Comprehensive Site OU (CSOU), which will address any residual contamination not addressed earlier. The timing and sequencing for implementation of activities associated with the OUs and GDP D&D are based on a combination of factors, including risk, compliance, and technical considerations associated with plant operations as outlined in the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998).

The objectives of each operable unit include taking early actions as necessary to prevent and reduce exposure and unacceptable risks. This includes completion of a series of prioritized response actions, ongoing site characterization activities to support future response action decisions, and D&D of the currently operating GDP once it ceases operation, followed by a comprehensive sitewide evaluation, with implementation of additional and final actions as needed to ensure long-term protectiveness. The intended scope, sequence, and timing of the OU initiatives are documented in the SMP (DOE 2011c) and in the FFA.

As described in the SMP, the following goals are used at PGDP to implement the phased approach for the Groundwater OU:

(1) Prevent human exposure to contaminated groundwater;
(2) Prevent or minimize further migration of contaminant plumes;
(3) Prevent, reduce, or control contaminant sources contributing to groundwater contamination; and
(4) Restore the groundwater to its beneficial uses wherever practicable.

In implementing this phased approach, the following Groundwater OU actions have been implemented to meet Goal 1 of preventing human exposure to contaminated groundwater:

- Provided an alternative source of drinking water to certain, nearby residences in the area of off-site contamination (1989); and

- Extended municipal water lines as a permanent source of drinking water to certain, nearby residences in the area of off-site contamination (1995).

The following additional actions have been taken to support meeting the other goals for the Groundwater OU:

- Constructed and implemented groundwater treatment systems for both the Northwest and Northeast Plumes to reduce contaminant migration (1995 and 1997, respectively);

- Applied *in situ* treatment of TCE-contaminated soil at the cylinder drop test site using innovative technology (i.e., the LASAGNA™ technology) to eliminate a potential source of groundwater contamination (DOE 2002b);

- Removed petroleum-contaminated soil from SWMU 193 to eliminate a potential source of groundwater contamination (DOE 2002b);

- Conducted a key groundwater treatability study to evaluate the effectiveness of the six-phase heating technology [Electrical Resistance Heating (ERH)] for *in situ* treatment of dense nonaqueous-phase liquid (DNAPL) at the C-400 Cleaning Building area (DOE 2003);

- Optimized the Northwest Plume Interim Remedial Action Extraction System (DOE 2011d); and

- Applied ERH remedial action for treatment of DNAPL at the C-400 Cleaning Building area.

Consistent with the results of the Groundwater OU FS (DOE 2001a) and the subsequent *Revised Focused Feasibility Study for the Southwest Groundwater Plume Volatile Organic Compound Sources (Oil Landfarm and C-720 Northeast and Southeast Sites) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2011a), this ROD focuses on reducing the concentration of TCE and other VOCs in the soils of the Upper Continental Recharge System (UCRS) at the C-747-C Oil Landfarm (SWMU 1) and C-720 Northeast (SWMU 211-A) and Southeast Sites (SWMU 211-B), which have been identified as the sources of groundwater contamination of TCE and other VOCs at the PGDP. These areas are located on-site within the plant secured area. This remedial action will use treatment to permanently reduce the toxicity, mobility, and volume of any principal threat source material (PTSM) associated with the VOC contamination at the C-747-C Oil Landfarm.

The portion of Plant Storm Sewer (SWMU 102) located between C-400 Building and Outfall 008 that was the subject of the Southwest Plume Site Investigation was not identified as a source of contamination to the groundwater; therefore, no further action is necessary for that portion of the SWMU 102.

The remedial action objectives (RAOs) for this action, which support Groundwater OU goals 2, 3, and 4 are as follows:

(1) Treat and/or remove the principal threat waste (PTW) consistent with the NCP.

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

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

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

Preferred Alternative 3 in the *Revised Proposed Plan 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—In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs is the selected remedial action for the VOC sources at SWMU 1 (Oil

Landfarm). The remedial action for SWMUs 211-A and 211-B at the C-720 Building will include (1) a Final Characterization/Remedial Design Support Investigation (FC/RDSI) of the extent and magnitude of contamination present in the subsurface soils followed by (2) a review of the data by the FFA parties and subsequent selection by the FFA parties of either *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs or Long-term Monitoring with Interim LUCs, which are Preferred Alternatives 8 and 2, respectively, in the Proposed Plan. The major components of the selected remedies include the following:

The selected remedial alternative for the Oil Landfarm (SWMU 1) consists of the following:

- Remedial design support investigation (RDSI)
- Injection and mixing of reagent into subsurface soil
- Confirmatory sampling
- Secondary waste management
- Site restoration
- Interim LUCs
- Groundwater monitoring

SWMUs 211-A and 211-B will undergo a FC/RDSI to determine contamination extent and magnitude followed by the selection of either Preferred Alternative 8 or 2 by the FFA parties and will consist of the following:

<u>Alternative 8</u>

- Installation of gravity feed enhanced *in situ* bioremediation (EISB*) syste*m
- Introduction of bioamendment
- Confirmatory sampling
- Secondary waste management
- Site restoration
- Interim LUCs
- Groundwater monitoring

or

<u>Alternative 2</u>

- Interim LUCs
- Groundwater monitoring

Additional details on the selected remedial alternatives are set forth in the Decision Summary and the Revised Proposed Plan. Following the FC/RDSI activity and the identification of the chosen alternative, a public notice will be published and placed in the AR indicating which remedial alternative will be implemented.

After completion of the actions described in this ROD, the impacts that any other groundwater-related contamination may have on human health and the environment, will be assessed as part of the Dissolved-Phase Groundwater Plume Remedial Action project, Groundwater OU, post-GDP project, and/or CSOU for the PGDP, as discussed in the SMP. Decisions about final remedial action for the Groundwater OU, which will meet the long-term, final cleanup goals for this OU, will be made in the future, after appropriate documentation and public review.

## 1.5 STATUTORY DETERMINATIONS

This remedial action satisfies, for VOC contamination in the UCRS soils, the mandates of CERCLA §121 and the requirements of the NCP to be protective of human health and the environment. The action will contribute to the final remediation of the Groundwater OU by removing a significant portion of the contaminant mass of TCE and other VOCs at the C-747-C Oil Landfarm through treatment. This action also will remove mass at SWMUs 211-A and 211-B through treatment if Alternative 8 is implemented following the final characterization investigation. This remedial action will reduce the time period the TCE concentration in groundwater remains above its MCL in the source areas and meets the statutory preference for attaining permanent solutions through treatment. The action also will meet federal and state applicable or relevant and appropriate requirements (ARARs) for the scope of this action. Based on currently estimated costs, the remedy is cost effective because it represents a reasonable value in remediation effectiveness for the money to be spent. In addition, this remedial action is consistent with Resource Conservation and Recovery Act (RCRA) corrective action requirements and the Hazardous Waste Facility Permit for affected SWMUs.

To the maximum extent practicable, this remedial action will utilize permanent solutions and alternative treatment technologies or resource recovery technologies. This remedial action also satisfies the statutory preference for treatment as a principal element of the remedy and to permanently and significantly reduce the volume, toxicity, and mobility of hazardous substances, pollutants, or contaminants. This remedial action will permanently remove a significant portion of the TCE and other VOCs in the C-747-C Oil Landfarm area through treatment via deep soil mixing and will result in reduction of TCE and other VOCs. At the C-720 Building source areas, the VOCs would be permanently removed through biological treatment with Alternative 8. If the results of the Final Characterization/RDSI data for either one or both of the C-720 Building sites indicate the extent and magnitude of contamination present in the subsurface soil does not warrant treatment, then Long-term Monitoring (Alternative 2) will be implemented and contaminant volumes will be reduced through dispersion, source depletion, and degradation. The remedial action will result in hazardous substances, pollutants, or contaminants remaining on-site above the remediation goal levels for TCE at 0.073 mg/kg and 0.075 mg/kg for the Oil Landfarm and C-720 Building sites, respectively, that allow for unlimited use and unrestricted exposure. Because contamination above levels that allow for unrestricted use and exposure will remain after completion of the action, statutory reviews will be conducted every five years to ensure that the remedy continues to be protective of human health and the environment. Interim LUCs also will be implemented to prevent exposure to non-VOC contamination and residual VOC contamination. Additional assessment of the C-747-C Oil Landfarm and C-720 Building sites will be included in the Groundwater OU and/or CSOU.

## 1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the AR file for this site.

- Contaminants of concern (COCs) and their respective concentrations (Section 2.7)
- Baseline risk represented by the COCs (Section 2.7)
- Potential remediation criteria for TCE in soil that will determine when implementation of total alternative is complete (Section 2.8)
- How source materials constituting principal threats are addressed (Section 2.11)

- Current and reasonably anticipated future land use assumptions (Section 2.6)
- Current and potential future beneficial uses of groundwater (Section 2.6 and 2.10)
- Estimated cost of the remedial action (Section 2.10)
- Key factors that led to selection of the remedy (Section 2.12)

## 1.7 ACCEPTANCE OF THE REMEDY

_______________________________ Date: _______________________________
William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy

_______________________________ Date: _______________________________
Franklin Hill
Director, Superfund Division
U.S. Environmental Protection Agency, Region 4

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# PART 2

# DECISION SUMMARY

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# PART 2. DECISION SUMMARY

## 2.1 SITE NAME, LOCATION, AND DESCRIPTION

The PGDP (site EPA ID KY 8-890-008-982) is located in McCracken County in western Kentucky, about 5.6 kilometers (3.5 miles) south of the Ohio River and approximately 16 kilometers (10 miles) west of the city of Paducah. This ROD addresses source reduction of TCE subsurface soil contamination found at the C-747-C Oil Landfarm (SWMU 1) and contamination in the C-720 Northeast and Southeast Sites (SWMUs 211-A and 211-B). The Plant Storm Sewer (part of SWMU 102) was demonstrated not to be a source of contamination to the Southwest Plume; therefore, no further action will be necessary at the section of the Plant Storm Sewer. The C-747-C Oil Landfarm, C-720 Northeast and Southeast Sites, and the Plant Storm Sewer are located inside the plant secured area.

DOE is the owner and serves as the lead agency for PGDP environmental restoration activities. Both the EPA and Kentucky Department for Environmental Protection (KDEP) are supporting regulatory agencies providing oversight for the DOE's environmental restoration of PGDP. In accordance with provisions of the FFA for PGDP, which DOE entered into with the Commonwealth of Kentucky and EPA in 1998, funding for this cleanup activity at PGDP is derived from federal appropriations for DOE.

PGDP is an operating gaseous diffusion plant that occupies approximately 650 acres and has produced enriched uranium since 1952. Most industrial activities are sited in a fenced security area with approximately 800 acres located outside the security fence. An additional 1986 acres of land is licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area.

## 2.2 SITE HISTORY AND ENFORCEMENT ACTIONS

The C-747-C Oil Landfarm is located in the southwest portion of PGDP. The C-747-C Oil Landfarm was used from 1973 to 1979 for the biodegradation of waste oils. The source of contamination at the C-747-C Oil Landfarm was from waste oils contaminated with TCE, uranium, polychlorinated biphenyls (PCBs), and 1,1,1-trichloroethane (TCA) spread on plots of land, which were tilled to a depth of 1 to 2 ft, limed, and fertilized.

The C-720 Building is a maintenance and machine shop facility that has supported PGDP activities since 1952. It is located in the southwest portion of the plant. The source of the contaminants to both the Northeast and Southeast Sites is not known. It is suspected that spills originated the C-720 Northeast site. These spills include leaks of solvents that were released during routine equipment cleaning and rinsing performed in the area.

The source of VOC contamination found at the C-720 Southeast site may have originated inside the building, with subsequent discharge to storm drains leading to the southeast corner of the building. The southeast portion of the building also houses instrument maintenance facilities and maintenance supply storage. The source materials may have been from spills or leaks on the loading dock or parking lot located to the southeast of the building.

After the discovery of off-site groundwater contamination at PGDP, DOE and EPA entered into an Administrative Order by Consent (ACO) on November 23, 1988, pursuant to CERCLA (EPA 1988). The ACO required the DOE to monitor area residential wells, provide an alternate drinking water source to affected residents, identify the nature and extent of contamination, and take action to protect human health and the environment. PGDP was listed on the CERCLA National Priorities List (NPL) on May 31, 1994. An FFA was completed and signed in 1998.

DOE has undertaken several remedial actions subsequent to the ACO to protect human health, to reduce the off-site migration of the portions of the groundwater plumes that contain the highest concentration of contamination and to address on-site sources of TCE and other VOCs. These actions include the following:

- Providing an alternate drinking water source to certain, nearby residences immediately after off-site groundwater contamination was discovered;

- Implementing a Water Policy that included extending water lines as needed to residents in a predetermined area and supplying public drinking water to such residences [*Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant* (DOE 1993a)];

- Constructing and implementing groundwater treatment systems for both the Northwest and Northeast Plumes to reduce contaminant migration by removing contaminant mass [*Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant* (DOE 1993b) and *Record of Decision for Interim Remedial Action at the Northeast Plume* (DOE 1995)];

- Applying *in situ* treatment of TCE-contaminated soil at the cylinder drop test site (SWMU 91) using an innovative technology (i.e., the LASAGNA™ technology) (DOE 1998b) to reduce a source of TCE contamination;

- Removing petroleum-contaminated soil from SWMU 193 to eliminate a potential source of groundwater contamination (DOE 2002a);

- Applying ERH to contaminated soils and groundwater at the C-400 Cleaning Building, which is the major source of contamination to off-site groundwater (*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); and

- Optimizing the Northwest Plume Interim Remedial Action extraction well field (*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&D2).

The source areas have been investigated and sampled several times since the discovery of off-site groundwater contamination. The Phase I Site Investigation (CH2M HILL 1991) included the C-747-C Oil Landfarm. The Phase I SI was an investigation of off-site areas impacted by migration of contaminants and identified the presence of the Northwest and Northeast Plumes. The Phase II SI included the C-747-C Oil Landfarm and investigation of C-720 Building (CH2M HILL 1992). Phase II focused on identifying and sampling of potential source areas for migration of off-site contaminants. Phase II SI Report identified both the C-720 Building and SWMU 1 as potential source areas requiring further investigation. Additional sampling at the C-747-C Oil Landfarm was performed to support the WAG 23 FS and the WAG 23 Remedial Action (RA) (DOE 1998a). The C-747-C Oil Landfarm and C-720 were included in the WAG 27 RI (DOE 1999a), which included geology, hydrogeology, and potential DNAPL source area descriptions for the three areas. The Groundwater OU FS refined the conceptual models for DNAPL distribution at source areas, including the C-747-C Oil Landfarm and C-720, and identified and evaluated general alternatives for remediating contaminated groundwater and source areas (DOE 2001a). The

Southwest Plume SI (DOE 2007) further refined the site conditions at the C-747-C Oil Landfarm and C-720 Building and concluded that the portion of SWMU 102 Storm Sewer was not a source to off-site contamination. DOE performed an FFS for the four SWMUs. The SWMUs, C-747-C Oil Landfarm (SWMU 1), and C-720 Northeast (211-A) and Southeast (211-B) Sites, source areas were included in the FFS where technology identification and screening were reviewed and updated as necessary and incorporated in the FFS (DOE 2010; DOE 2011a). The storm sewer was included in the FFS, but did not have alternatives developed for it since it was concluded not to be a source of VOC contamination. Therefore, no further action is necessary for that portion of the SWMU and since remedial alternatives were not developed, then no alternative is being selected for the area.

## 2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The FS for the Groundwater OU at the PGDP in Paducah, Kentucky, was made available to the public on November 2, 2001. Copies of the document can be found in the AR file located at the DOE Environmental Information Center located at 115 Memorial Drive, Paducah, KY. The notice of availability of the Groundwater OU FS was published in a regional newspaper, *The Paducah Sun*, on November 2, 2001. A public comment period was held from November 2, 2001, to December 17, 2001.

The Revised FFS for the Southwest Plume VOC sources (C-747-C Oil Landfarm, C-720 Northeast and Southeast Sites, and Plant Storm Sewer), was made available to the public on May 16, 2011. Copies of the document can be found in the AR file.

The Revised PP for the TCE sources at the Southwest Plume (C-747-C Oil Landfarm, C-720 Building areas, and Plant Storm Sewer) was made available to the public on TBD. It can be found in the AR file. A public comment period was held from TBD to TBD. All written and verbal comments received from the public and other stakeholders are discussed in the Responsiveness Summary, Section 3.2. Specific groups that received individual copies of the PP include the Natural Resource Trustees and the PGDP Citizens Advisory Board.

## 2.4 SCOPE AND ROLE OF THE OPERABLE UNIT

As discussed in Section 1.4, site cleanup includes a series of prioritized response actions for each OU. The timing and sequencing for implementation of activities including response actions associated with the OUs and GDP D&D are based on a combination of factors, including risk, compliance, and technical considerations associated with plant operations as outlined in the FFA.

In accordance with the FFA, all SWMUs and areas of concern requiring investigation and/or potential response actions under the FFA have been assigned to one of the five media-specific OUs listed above. 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.

The VOC source areas at the C-747-C Oil Landfarm, C-720 Northeast and Southeast Sites, and the storm sewer also are part of the Groundwater OU. These selected remedies will address the migration of VOCs from the C-747-C Oil Landfarm and the C-720 Building Area to the Southwest Plume and will treat potential PTW. Based on results from the Southwest Plume SI, the Storm Sewer no longer is considered a source of VOC contamination to the Southwest Plume. Risks posed by direct contact with contaminated surface soil or sediment at the C-747-C Oil Landfarm and C-720 Building Area or remaining risks from potential use of contaminated groundwater from non-VOC contaminants will be mitigated with interim LUCs and also will be addressed later as part of the decisions for the Soils OU and Groundwater OU.

Consistent with EPA guidance (EPA 2004a), the Groundwater OU is being implemented in a phased approach consisting of sequenced remedial and removal actions designed to accomplish the following goals:

(1) Prevent human exposure to contaminated groundwater;
(2) Prevent or minimize further migration of contaminant plumes;
(3) Prevent, reduce, or control contaminant sources contributing to groundwater contamination; and
(4) Restore the groundwater to its beneficial uses, wherever practicable.

This final VOC remedial action will support the phased groundwater goals represented in goals 2, 3 and 4 by controlling VOC migration (including potential DNAPL) that contribute to groundwater contamination, thereby promoting the restoration of groundwater to beneficial use, as practicable. The remedial action also is anticipated to reduce substantially the risk and hazard from hypothetical groundwater use associated with releases from these source areas.

Evaluation of a final remedial action for additional COCs (non-VOCs) associated with direct contact exposure risks will be addressed by the Soils OU, as described in the 2011 SMP (DOE 2011c). Groundwater contamination will be addressed through the Dissolved-Phase Plumes Remedial Action.

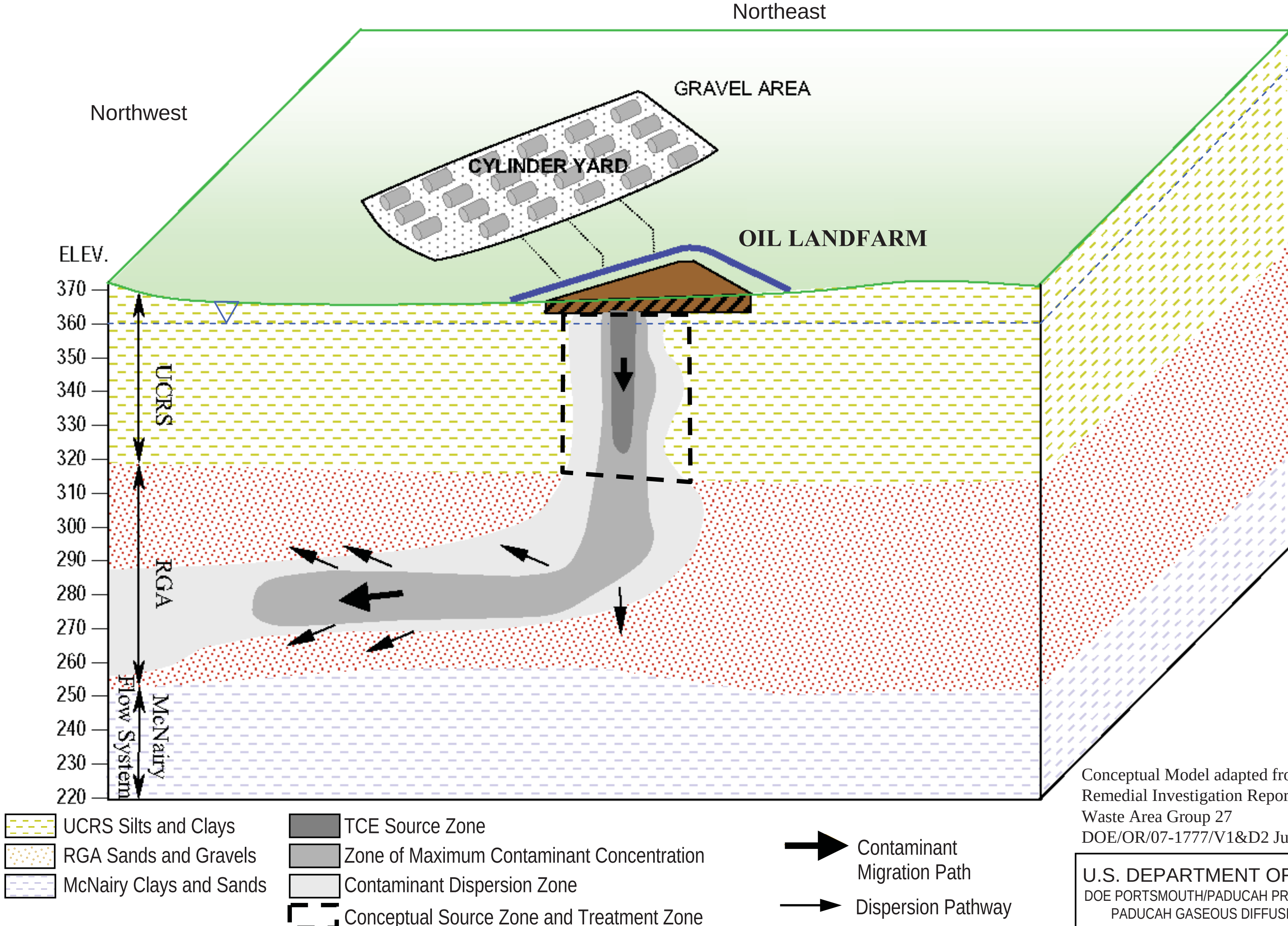
## 2.5 SUMMARY OF SITE CHARACTERISTICS

### 2.5.1 Conceptual Site Model

The conceptual site model (CSM) is a three-dimensional “picture” that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. Figure 1 represents the CSM for the C-747-C Oil Landfarm, and Figure 2 represents the CSM for the C-720 Northeast and Southeast Sites. Figure 3 shows the conceptual exposure site model for the C-747-C Oil Landfarm and the C-720 Northeast and Southeast Sites.

The assessments in the Southwest Plume SI, implemented in 2004, concluded that TCE and other VOCs are present at the C-720 Northeast and Southeast Sites and the C-747-C Oil Landfarm as isolated droplets/ganglia dispersed in the soil of the UCRS. These residual source zones of TCE are found in the upper 18.3 m (60 ft) of soils. Only TCE dissolved in water is believed to be present in the gravels of the RGA at these locations. The much lower hydraulic conductivity of the McNairy Formation, underlying the RGA, limits vertical migration of dissolved contamination below approximately 30.5 m (100 ft).

For the source zones comprised of TCE and other VOCs at the C-720 sites and the C-747-C Oil Landfarm, the primary pathway of contaminant migration is dissolution of contaminant residual comprised of TCE and other VOCs into groundwater in the UCRS and downward migration into the RGA. Dissolved contaminants from these sources subsequently migrate toward the west-northwest in the RGA. Groundwater samples from the RGA in the Southwest Plume support the conclusion that the Southwest Plume has not migrated beyond the DOE property line, which is 914 m (3,000 ft) and 1,460 m (4,789 ft) from the C-747-C Oil Landfarm and the C-720 Building area, respectively. From the point where




Conceptual Model adapted from
Remedial Investigation Report for
Waste Area Group 27
DOE/OR/07-1777/V1&D2 June 1999

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

LATA Environmental Services of Kentucky, LLC

**Figure 1. Conceptual Model for the SWMU 1 TCE Source Area**



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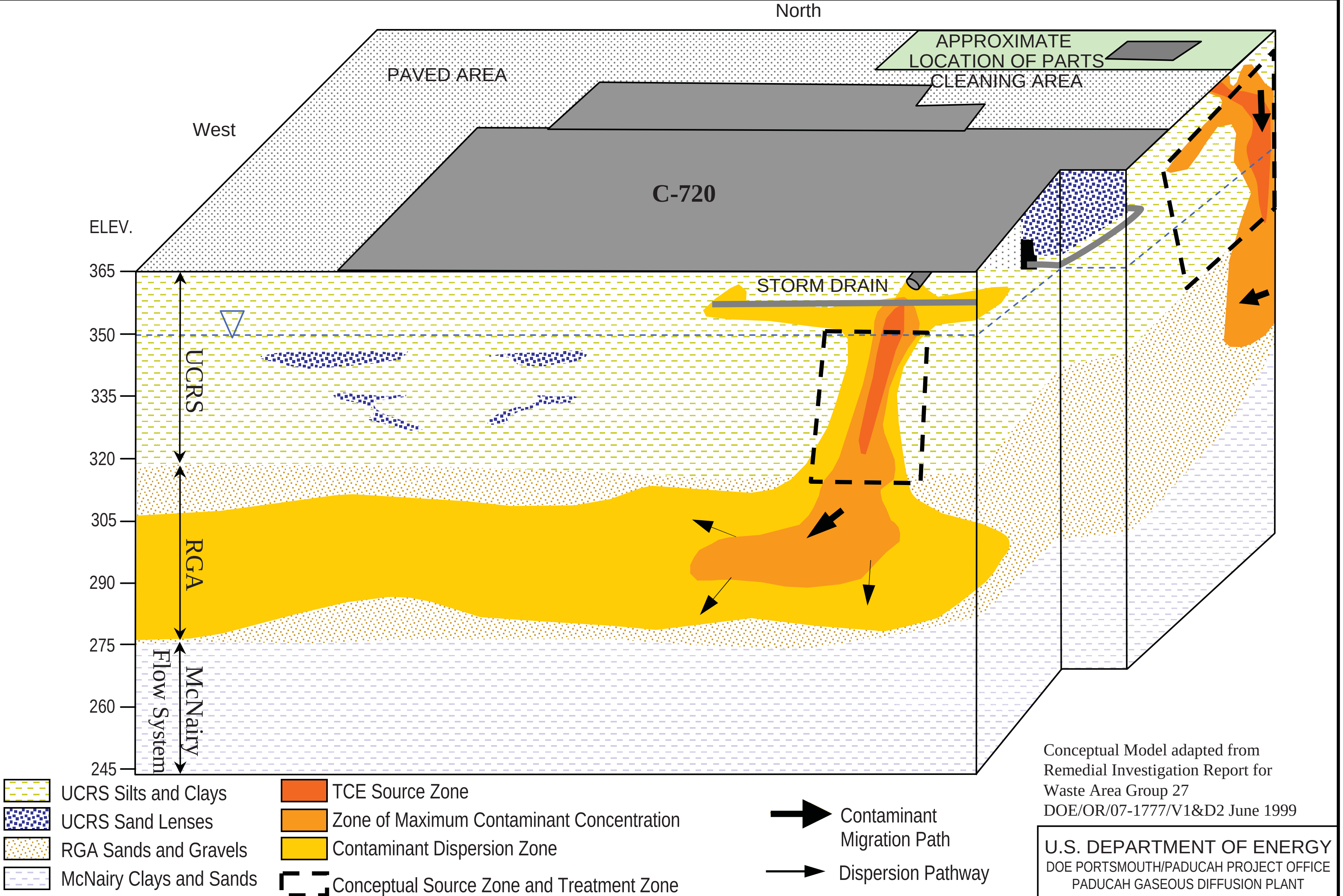


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

**Figure 2. Conceptual Model for the C-720 TCE Source Areas**

LATA Environmental Services of Kentucky, LLC

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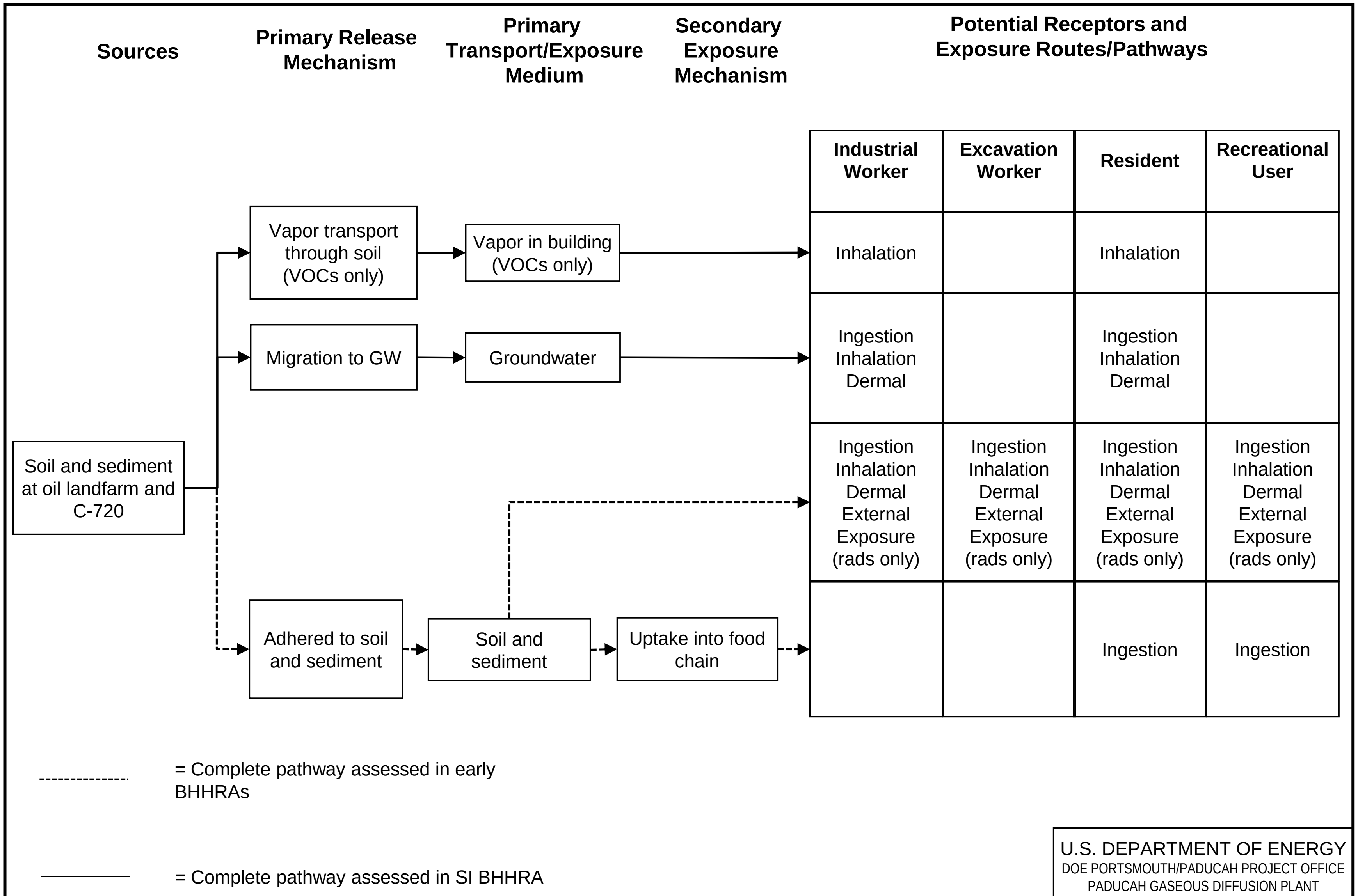


**Figure 3. Exposure Route/Pathway Conceptual Model for the Southwest Plume Source Areas***

*Figure derived from Figure 1.19, D2 Revised Focused Feasibility Study, DOE/LX/07-0362&D2, May 2011.

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the groundwater flow path that includes the Southwest Plume crosses the DOE property line, the modeled particle flow path distance to potential points of exposure to RGA groundwater near the Ohio River is approximately 6.4 km (4.0 miles).

### 2.5.2 Overview of the Site/Surface and Subsurface Features

Each of the Groundwater OU source areas of TCE and other VOCs to the Southwest Plume (the C-720 Northeast and Southeast Sites and the C-747-C Oil Landfarm) has flat topography, with elevations ranging from approximately 112.8 to 114.6 m (370 to 376 ft) above mean sea level. The area around the east end of the C-720 Building is mostly covered by concrete or asphalt with intermittent small areas of exposed soil. Eighth Street lies to the east of the building. Adjacent to the northeast corner of the building is a concrete and asphalt parking and maintenance area. The southeast corner of the building has a parking lot and a material loading and unloading dock adjacent to it. The total area of TCE contamination is limited to 0.3 acres for both the C-720 Southeast and Northeast sites. The highest levels of soil contamination have been found beneath the concrete and asphalt-covered, southeast parking lot and adjacent to the intersection of a buried storm-water drain issuing from the facility and a main storm-water sewer line on the south side of the C-720 Building that eventually discharge through Outfalls 008 and 009 to Bayou Creek.

The C-747-C Oil Landfarm is a grass-covered area of approximately 2.2 acres. Contaminated subsurface soils underlie an area of 0.2 acres. No utilities are present in the immediate area of contaminated soil. Drainage ditches border the C-747-C Oil Landfarm on the north, south, and west sides. Storm water runoff from the C-745-A Cylinder Storage Yard, which lies to the north, flows to these perimeter ditches and discharges via the Outfall 008 ditch to Bayou Creek.

### 2.5.3 Sampling Strategy

Previous investigations, notably the WAG 27 RI (DOE 1999a), identified the main extent of contamination at the C-720 Building and the C-747-C Oil Landfarm. The primary focus of the Southwest Plume SI in these Groundwater OU source areas was to collect sufficient data to refine the knowledge of the extent of contamination; by profiling levels of VOC contamination with a Membrane Interface Probe (MIP) in the UCRS soils around the perimeter of known soil contamination; and by collecting discrete UCRS soil samples for laboratory analysis of contaminant levels. Figures 4 and 5 show the locations and TCE results of UCRS soil sampling from the Southwest Plume SI and previous investigations that were used to define these VOC source zones.

At the C-720 Building southeast site, the 2004 SI profiled VOC levels in two locations to a depth of 18.3 m (60 ft) and collected and analyzed four soil samples from each of two direct push technology (DPT) soil borings, located adjacent to the VOC profile locations. The SI similarly sampled six borings around an area of lesser contaminant mass in the northeast site. Likewise, at the C-747-C Oil Landfarm, the Southwest Plume SI profiled VOC levels and collected UCRS soil samples in five locations on the perimeter of known contamination. Each DPT soil boring was completed to a depth of 18.3 m (60 ft) and four soil samples were collected and analyzed from depths of maximum VOC levels in each boring.

Concerns developed after a 1997 RI of the C-400 Cleaning Facility (DOE 1999b) identified that potential leaks of TCE and other contaminants from the Outfall 008 storm sewer that drains the area near the C-400 Cleaning Building may have infiltrated adjacent soils and that these soils were a continuing source of dissolved contamination to the Southwest Plume. Soil and groundwater analyses were unavailable in the area of the Outfall 008 storm sewer. To investigate the Outfall 008 storm sewer, the Southwest Plume SI completed a video survey of the storm sewer downstream of the C-400 Cleaning Building to identify locations of fractures and damaged joints and then characterized the soils adjacent to 15 of these fractures

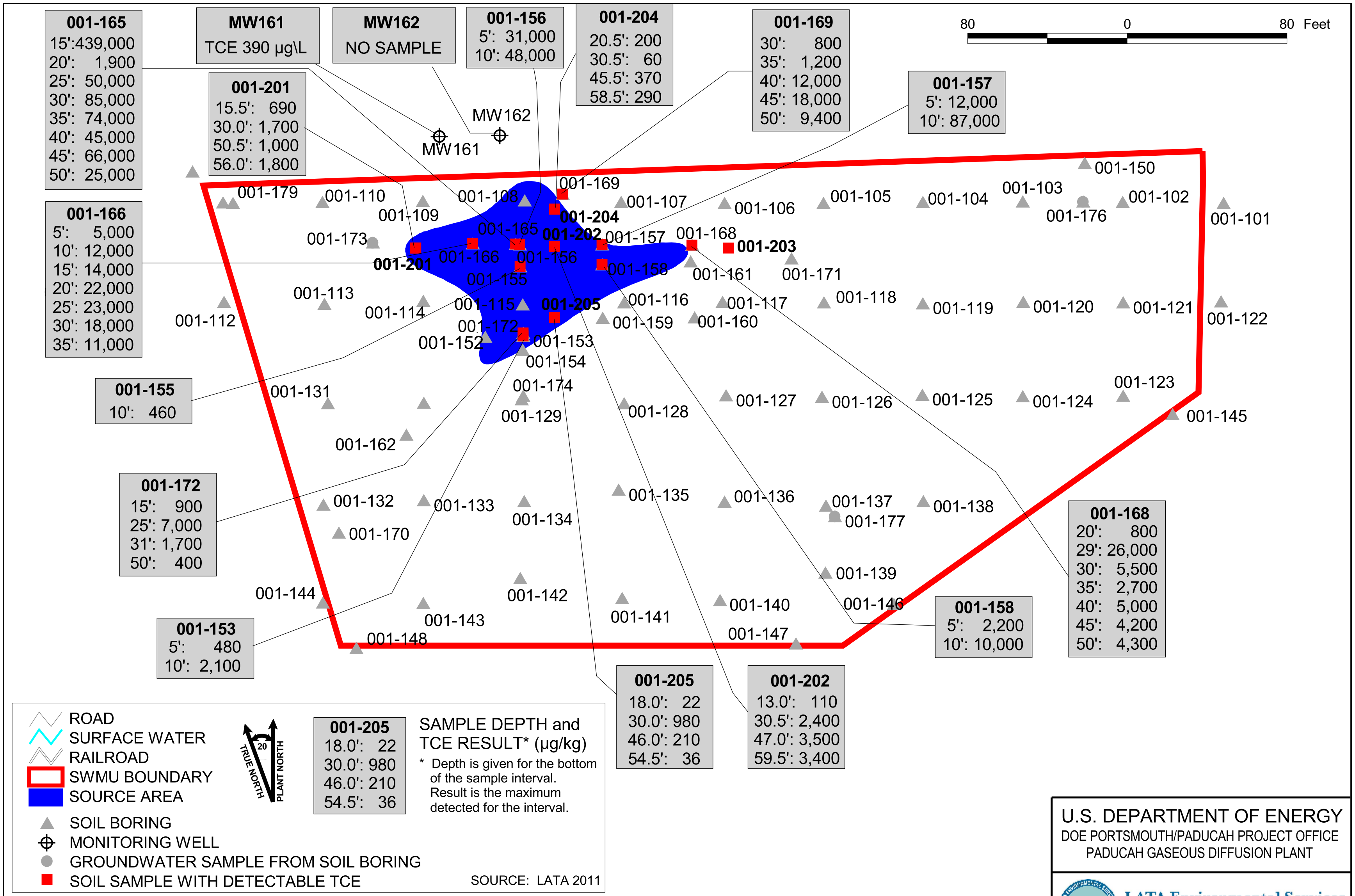


**Figure 4. TCE Results from Oil Landfarm Sampling**

Figure No. C5AC90005SK007R3_5_1.20r1.apr
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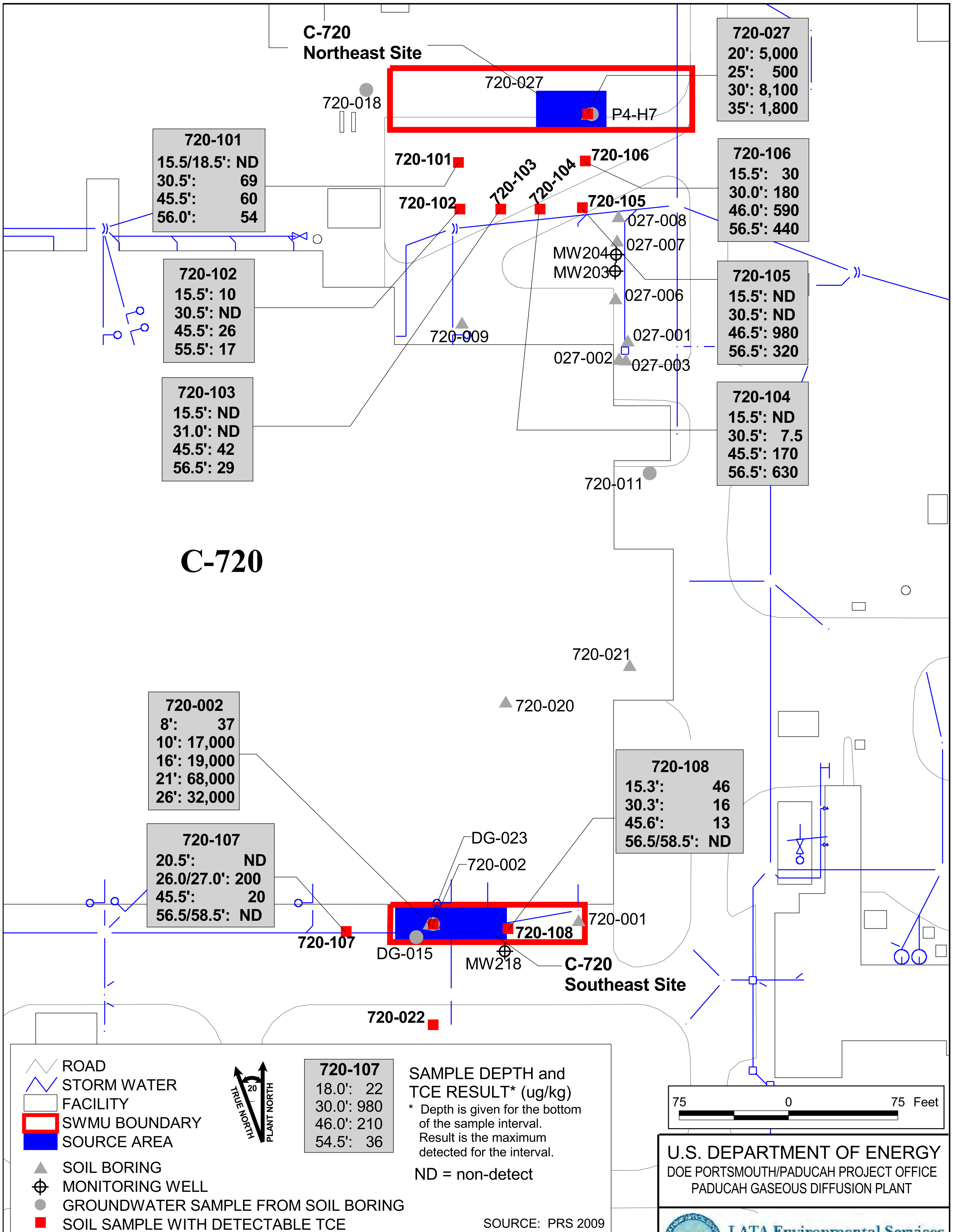


**Figure 5. TCE Results from C-720 Building Area Sampling**

Figure No. C5AC90005SK007R3_5_1.21.apr
DATE 12-03-2010

and joints. At each of the 15 locations, the SI profiled VOC levels in the soil with a MIP to a depth of 6.1 m (20 ft), the depth of the base of the storm sewer, and collected and analyzed one soil sample from near the base of the storm sewer with a DPT soil boring.

The Southwest Plume SI determined that the remaining mass of VOC contamination associated with the C-720 Northeast and Southeast Sites and the C-747-C Oil Landfarm was a source of contamination to the RGA groundwater; however, the results from soils adjacent to the storm sewer proved that section of the storm sewer had not leaked and was not a source of groundwater contamination, and no further action is necessary.

### 2.5.4 Known and Suspected Sources of Contamination

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 which 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-TCA between 1973 and 1979. These waste oils are believed to have been derived from a variety of plant processes. The Landfarm consisted of two 105 $m^2$ (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.
**Types of Contamination and the Affected Media.** Sample analyses from the Southwest Plume SI and previous investigations indicate that the primary site-related VOCs in subsurface soil in the Groundwater OU source zones are TCE and its breakdown products [*cis*-1,2-dichloroethene (*cis*-1,2-DCE), *trans*-1,2-dichloroethene (*trans*-1,2-DCE), and vinyl chloride (VC)]. Other VOCs detected in area investigations include acetone; 2-butanone; 1,1-dichloroethane; and 1,2-DCE. The UCRS contains high VOC concentrations. The following summarizes characteristics of the primary VOCs present in soils at the C-720 Northeast and Southeast Sites and C-747-C Oil Landfarm source zones.

**TCE.** Trichloroethene was the primary VOC detected in the subsurface soil. This contaminant is a halogenated organic compound used by industry in the past for a variety of purposes. One primary use at PGDP was as a degreasing agent. Exposure to this compound has been associated with deleterious health effects in humans, including anemia, skin rashes, liver conditions, and urinary tract disorders. Based on laboratory studies, TCE is considered a probable human carcinogen. Over time, TCE naturally degrades to other organic compounds. TCE use at PGDP was discontinued in 1993.

**1,2-DCE, *cis*- and *trans*.** 1,2-Dichloroethene exists in two isomeric forms, *cis*-1,2-DCE and *trans*-1,2-DCE. Although not utilized extensively in industry, 1,2-DCE is used both in the production of other chlorinated solvents and as a solvent. Humans are exposed to 1,2-DCE primarily by inhalation, but exposure also can occur by oral and dermal routes. Information on the toxicity of 1,2-DCE in humans and animals is limited. Studies suggest that the liver is the primary target organ. EPA does not classify 1,2-DCE as a human carcinogen.

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

The size and volume of the source zones comprised of TCE at the C-720 Building and the C-747-C Oil Landfarm were estimated in the Southwest Plume SI. At both locations, the distribution and levels of TCE in the UCRS soils indicate that the contamination is a residual TCE source zone, which subsequently leaches into the groundwater as a dissolved phase and migrates into the RGA aquifer. Additional information about these Groundwater OU source zones can be found in the Southwest Plume SI Report and documents of previous investigations of the units. These documents (which are part of the AR for this response action) can be examined at the DOE Environmental Information Center.

The TCE present in the soil addressed by this interim remedial action has originated from activities formerly conducted at PGDP. These activities included use of TCE as a degreaser and as a cleaning solvent. Spills of unused TCE also have been documented. Environmental media and debris contaminated with this spilled TCE may carry hazardous waste numbers F001, F002, and U228 under RCRA. These media and debris must be handled appropriately, in accordance with Appendix, titled “Applicable or Relevant and Appropriate Requirements.”

### 2.5.5 Affected Aquifers and Groundwater Flow Directions

The shallow aquifer underlying PGDP is the RGA. Groundwater flow within the RGA is west-northwest in the areas of the C-720 Building and the C-747-C Oil Landfarm. Based on particle track modeling, RGA groundwater flow and entrained contaminants after leaving the PGDP area flow north-northeast eventually discharging into the Ohio River and adjacent streams. Low-conductivity sediments overlie the RGA to a depth of approximately 18 m (60 ft). Groundwater flow in the overlying sediments is principally downward to recharge the RGA. This flow system is termed the UCRS.

### 2.5.6 Location of Contamination and Routes of Migration

As discussed in the previous section, the Southwest Plume SI estimated the extent of the TCE source zones in the C-720 Building area and the C-747-C Oil Landfarm. Figures 1 and 2 presents the conceptual location of the contaminant source treatment zones to be addressed in this ROD. As shown, contamination by TCE and other VOCs is known to extend through the UCRS soils (with a base at approximately 18.3 m (60 ft) bgs.

Monitored contaminant levels in the RGA groundwater associated with the Southwest Plume provide empirical evidence of contaminant mobility. Three large plumes of dissolved contaminants have migrated beyond the secured fenced area. The PGDP’s Northwest Plume reaches 4.6 km (2.8 miles) beyond the PGDP secured fenced area to Little Bayou Creek in the Ohio River floodplain. Both human receptors and wildlife are exposed to the Northwest Plume contaminants at seeps in and along Little Bayou Creek. The Northeast Plume extends approximately 3.5 km (2.2 miles) from the east side of PGDP northward to Metropolis Lake Road. Contamination within the Northeast Plume does not discharge to the surface. The Southwest Plume extends approximately 0.2 km (0.1 miles) west of the PGDP security fence and is completely contained within PGDP property. Potentiometric surface maps of the RGA and groundwater flow modeling indicate that the Southwest Plume travels northward over time and join with PGDP’s Northwest Plume. Based on recent (2010 and 2011) groundwater potentiometric maps of the RGA, the southern extraction zone of the NW plume groundwater pump and treat system is capturing the flow from the southwest plume and effectively removing the TCE from the groundwater. The source zones for the C-747-C Oil Landfarm and the C-720 Building sites contribute contaminants to the Southwest Plume.

DOE provides municipal water to certain, nearby residents and businesses and this serves to limit off-site human exposure to contaminated groundwater.

## 2.6 CURRENT AND POTENTIAL FUTURE LAND USE

According to the SMP, current and reasonably foreseeable future land uses at and adjacent to PGDP are for industrial areas located primarily inside the security fence, recreational areas located outside the security fence, and residential areas off DOE property. This land use determination was made after consideration of (1) existing lease agreements, (2) the nature of contamination currently present at the facility, and (3) stakeholder input.

Because the C-747-C Oil Landfarm and C-720 Building areas are located inside the PGDP security fence, the area is currently industrial and is expected to remain industrial land use in the future. There are no current exposures to groundwater on-site because of existing on-site restrictions and controls.

As noted in Section 2.5.6 and in the above paragraphs, TCE and other VOCs in soil and groundwater in C-747-C Oil Landfarm and C-720 sites originate in an area where current and expected future land use is industrial and are migrating to areas where current and expected future land use is recreational. Upon implementing these remedial actions, the TCE source materials at SWMU 1 will be reduced in quantity and will to lead to reductions in any TCE concentrations in the groundwater. There are no current exposures to groundwater on-site because of existing on-site restrictions and controls, (e.g., the current excavation/penetration permit program). The RGA groundwater has not been formally classified, but would be considered a Class II groundwater under EPA Groundwater Classification guidance (EPA 1986).

DOE plant controls associated with the C-747-C Oil Landfarm and the C-720 Northeast and Southeast Sites consist of security/access controls, including fencing and security patrols that are established and maintained outside of CERCLA, and are effective at preventing public access. Additionally, groundwater protection measures described in the Action Memorandum for the Water Policy at PGDP, which is an ongoing CERCLA action, protect residents from the risks associated with the using contaminated groundwater. These controls are not LUCs included in this RA. They are effective at preventing public access and unwanted trespassers to contaminated areas of PGDP.

## 2.7 SUMMARY OF SITE RISKS

The baseline risk assessment estimates the risks that a site poses to human and ecological receptors if no action is taken (i.e., if the existing Water Policy action limiting groundwater use at and near PGDP were not in place). It provides the basis for action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the methods used to characterize the baseline risks posed to human health and the environment resulting from contact with contaminants at the C-747-C Oil Landfarm, C-720 Building areas, the Storm Sewer, and in the Southwest Plume. Results presented here were taken from *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2/R1 (DOE 2007).

The baseline human health risk assessment (BHHRA) presented in the SI utilized information collected during the recently completed SI (DOE 2007) of four potential sources to the Southwest Plume (SWMU 210) and results of previous risk assessments for these sources in the WAG 27 RI (DOE 1999a). The purpose of the BHHRA was to characterize the baseline risks posed to human health from contact with contaminants in soil and water at these sources and at locations to which contaminants may migrate. The sources included are the C-747-C Oil Landfarm, two areas near the C-720 Building, and the storm sewer line running from near the C-400 Building to Outfall 008. The SI BHHRA focused on the assessment of risks resulting from the hypothetical household use of contaminated water drawn from the RGA at the source areas, within the boundaries of the Southwest Plume, and at points of exposure (POEs) at the PGDP plant boundary, PGDP property boundary, and near the Ohio River. Potential risks under other scenarios resulting from exposure to contaminated surface and subsurface soil identified are reported, but these risks were taken from the earlier assessments and were not reassessed as part of the SI BHHRA.

The previous risk assessments that were useful in understanding the risks to human health posed by exposure to contaminants at or migrating from the sources to the Southwest Plume are in the following:

- *Remedial Investigation Report for WAG 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1999b);

- *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001a); and

- *Contaminant Migration from SWMU 1 and the C-720 Area at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2003).

These results were used because they were from studies that used methods consistent with those described in the Risk Methods Document (DOE 2001b) and are the most recently completed. The WAG 27 RI report presents results from earlier assessments.

### 2.7.1 Summary of Baseline Human Health Risk Assessment

This section summarizes the steps of the SI BHHRA and presents significant results used in making the current decisions for the VOC sources at the C-747-C Oil Landfarm, C-720 Building areas, and the storm sewer which was determined to not be a source of groundwater contamination.

Evaluation of a final remedial action for additional COCs (non-VOCs) associated with soil exposure risks will be addressed by the Soils OU, and the groundwater contamination will be addressed through the Dissolved-Phase Plumes Remedial Action.

#### 2.7.1.1 Identification of COCs

This section presents the VOC COCs for the source area contamination found at the C-747-C Oil Landfarm, C-720 Building areas, and the storm sewer. The following information is included:

- POE (i.e., the location where the receptor may actually or potentially contact the contaminated media);

- COC (i.e., a contaminant that presents a risk level greater than $10^{-6}$ or a hazard threshold greater than 0.1);

- Minimum and maximum detected concentration;

- Units of measure for the detected concentration;

- Frequency of detection;

· Exposure point concentration (EPC) (i.e., the concentration of the chemical used in deriving the risk estimate at the POE); and

· Statistical measure (i.e., the summary statistic used to represent each COC's average EPC).

The medium to be addressed by this ROD is the subsurface soil that contains TCE and other VOCs at the C-747-C Oil Landfarm, C-720 Building areas, and storm sewer areas; therefore, only COCs related to this medium are summarized here. Table 1 lists VOC COCs for direct exposure to groundwater. Although no soil exposure assessment was conducted, subsurface soil data were used to complete environmental fate and transport modeling. These modeled water concentrations (Table 2) were used in the SI BHHRA to estimate future risks from contaminants in groundwater at the POEs to which contaminants may migrate, specifically the plant boundary, the property boundary, and near the Ohio River.

The COCs were selected following methods presented in *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001b). Using this guidance, COCs are defined as contaminants detected at a site that significantly contribute to a pathway in a use scenario for a receptor that either (a) exceeds a cumulative excess lifetime cancer risk (ELCR) of $1 \times 10^{-6}$, or (b) exceeds a cumulative noncarcinogenic hazard index (HI) of 1. Chemicals are considered to be significant contributors to risk if their individual carcinogenic risk contribution is greater than $10^{-6}$ or their noncarcinogenic hazard quotient (HQ) is greater than 0.1.

**Table 1. Summary of VOC COCs from Baseline Risk Assessment and EPCs for Contact with Groundwater at Southwest Plume Source Areas**

| **Scenario Time frame: Future** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Medium: Groundwater** | | | | | | | | |
| **Exposure Medium: Groundwater** | | | | | | | | |
| **POE** | **COC** | **Min** | **Max** | **Units** | **Frequency of Detection** | **EPC** | **Units** | **Statistical Measure** |
| SWMU-1 | 1,1-Dichloroethene | 5.00E-04 | 7.00E-04 | mg/L | 2/27 | 7.00E-04 | mg/L | Max |
| SWMU-1 | Chloroform | 3.20E-03 | 3.20E-03 | mg/L | 1/19 | 3.20E-03 | mg/L | Max |
| SWMU-1 | Trichloroethene | 1.00E-04 | 7.80E-01 | mg/L | 25/28 | 7.80E-01 | mg/L | Max |
| SWMU-1 | *cis*-1,2-Dichloroethene | 3.00E-02 | 6.70E-02 | mg/L | 2/27 | 6.70E-02 | mg/L | Max |
| C-720 | 1,1-Dichloroethene | 7.00E-04 | 5.40E-02 | mg/L | 8/31 | 5.40E-02 | mg/L | Max |
| C-720 | Trichloroethene | 3.80E-03 | 1.26E+00 | mg/L | 31/31 | 7.38E-01 | mg/L | UCL 95 |
| C-720 | Vinyl chloride | 2.10E-03 | 2.10E-03 | mg/L | 1/31 | 2.10E-03 | mg/L | Max |
| C-720 | *cis*-1,2-Dichloroethene | 3.00E-04 | 3.10E-02 | mg/L | 9/31 | 3.10E-02 | mg/L | Max |
| Storm Sewer | 1,1-Dichloroethene | 1.00E-04 | 1.00E-04 | mg/L | 2/8 | 1.00E-04 | mg/L | Max |
| Storm Sewer | Trichloroethene | 9.00E-05 | 1.00E-02 | mg/L | 8/8 | 1.00E-02 | mg/L | Max |

**Table 2. Modeled Concentrations of the TCE Contaminant at the PGDP Fence Boundary, PGDP Property Boundary, and near the Ohio River**

| | Plant Boundary | | Property Boundary | | Near Ohio River | |
|---|---|---|---|---|---|---|
| **COC** | **Predicted Time of Maximum Concentration (years)** | **Maximum Mean Concentration (μg/L)** | **Predicted Time of Maximum Concentration (years)** | **Maximum Mean Concentration (μg/L)** | **Predicted Time of Maximum Concentration (years)** | **Maximum Mean Concentration (μg/L)** |
| *SWMU 1 Source Area–Variable Degradation Scenario* | | | | | | |
| Trichloroethene | 15 | 71.9 | 40 | 5.05 | NA | 0 |
| *SWMU 1 Source Area–Fixed Degradation Scenario* | | | | | | |
| Trichloroethene | 15 | 112.0 | 25 | 18.1 | 80 | 1.8 |
| *C-720 Building Area–Variable Degradation Scenario* | | | | | | |
| Trichloroethene | 45 | 3.1 | 50 | 0.74 | NA | 0 |
| *C-720 Building Area–Fixed Degradation Scenario* | | | | | | |
| Trichloroethene | 30 | 15.7 | 45 | 7.97 | NA | 0 |

### 2.7.1.2 Exposure assessment

This section summarizes the results of the exposure assessment that was performed as part of the BHHRA for the C-747-C Oil Landfarm, C-720 Building areas, and the storm sewer, with specific attention to the exposure routes that were quantitatively evaluated and that are relevant to the selected action. Generally, exposure assessment is a procedure in which pathway analysis is used to identify significant pathways of human exposure, and exposure equations are used to quantify doses to or intakes of receptors. Throughout the exposure assessment, the guiding principle is that, in order to be quantified, the exposure pathway has to be complete either now or in the future. A complete pathway is one that includes a source of contamination and mechanism of release, a method of transport or retention, a POE, and a route of exposure. If any of these parts are absent, then the exposure pathway is deemed incomplete and is not quantified in the risk assessment.

The SI BHHRA assessed risk resulting from the hypothetical household use of contaminated water drawn from the RGA at the source areas, within the boundaries of the Southwest Plume, and at POEs at the PGDP plant boundary, PGDP property boundary, and near the Ohio River. Pathway analysis in the SI BHHRA identified one human health exposure scenario (rural resident) to be evaluated. The off-site rural residential scenario in the risk assessment assessed risks at three points of exposure (i.e., plant boundary, property boundary, and Ohio River). To be consistent with the earlier BHHRAs, this assessment assumes that future use of groundwater drawn from the RGA below the source units is possible even though current response actions eliminate the possibility that a rural resident may be exposed to contaminated groundwater. It also assumes that water supply wells will be placed at downgradient POEs where the maximum contaminant concentration within the Southwest Plume will occur in the future. The exposure routes assessed for the off-site rural residential scenario included ingestion of groundwater, dermal contact with groundwater during showering, inhalation of vapors emitted by groundwater during showering and during household use, and inhalation of volatiles as a result of vapor intrusion into home basements.

Previous risk assessments evaluated exposure to soil, sediment, groundwater, surface water, and game at the C-747-C Oil Landfarm and C-720 Building areas by on-site industrial workers, on-site excavation workers, on-site recreational users, on-site rural residents, off-site recreational users, and off-site rural residents. Evaluation of a final remedial action for additional COCs (non-VOCs) associated with soil exposure risks will be addressed by the Soils OU and the non-VOC groundwater contamination will be addressed through the Dissolved-Phase Plumes RA.

Exposure parameters used in all exposure equations were those used to derive chronic dose estimates (a chronic dose estimate is one derived assuming repeated daily exposure to a contaminated medium over several years.); therefore, the use of these parameters yielded dose estimates that allowed for the estimation of dose over a lifetime of exposure (i.e., 40 years for the resident) under frequent use (i.e., 350 days/year for the resident.) Also, in keeping with current agreements, doses used to calculate residential risk estimates included exposure durations for both a child (6 years) and an adult (34 years). The values used for all other exposure parameters were taken from those approved by decision makers. Use of these parameters and the EPCs presented in Tables 2 and 3 yielded reasonable maximum exposure (RME) estimates of dose.

### 2.7.1.3 Toxicity assessment

This section summarizes the salient points of the toxicity assessment contained in the SI BHHRA. As with the earlier discussion of COCs, most information is contained in the tables presented in this section. Many of the toxicological summaries were obtained from information drawn from the *Risk Assessment Information System* prepared by the Toxicology and Risk Analysis Section of Oak Ridge National Laboratory for DOE (DOE 2004). This site also lists toxicity values taken from the EPA's Integrated Risk Information System (IRIS) database (EPA 2004b), National Center for Environmental Assessment (NCEA), and Health Effects Assessment Summary Tables (HEAST) database (EPA 2001). Table 3 presents cancer toxicity data summary and Tables 4 and 5 present toxicity values for exposure to noncarcinogens.

### 2.7.1.4 Risk characterization

This section describes how the outputs from the exposure assessment (i.e., RME doses) and toxicity assessment (toxicity values) were combined to characterize the baseline risks. As with the earlier sections, most information is presented in tables. This section concludes with a short discussion of the uncertainties affecting the results presented.

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime because of exposure to the carcinogen. ELCR is calculated from the following equation:

$Risk = CDI \times SF$

where: risk = a unitless probability (e.g., $2 \times 10^{-5}$) of an individual's developing cancer,
CDI = chronic daily intake averaged over 70 years [mg/(kg x day)],
SF = slope factor, expressed as $[mg/(kg \times day)]^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., $1\times10^{-6}$ or 1E-6). EPA's target risk range for site-related exposures is $10^{-6}$ to $10^{-4}$ (or 1E-06 to 1E-04).

**Table 3. Cancer Toxicity Data Summary for the SI BHHRA for Source Areas at Oil Landfarm, Building C-720 Areas, and the Storm Sewer**

| **Route: Ingestion and Dermal Contact** | | | | | | |
|---|---|---|---|---|---|---|
| **COPC[a]** | **Oral Cancer Slope Factor[b]** | **Dermal Cancer Slope Factor** | **Slope Factor Units** | **Weight of Evidence/Type of Cancers** | **Source[c]** | **Date Accessed** |
| 1,1-Dichloroethene | 6.00E-01 | 6.00E-01 | $(mg/kg \times day)^{-1}$ | Kidney, adenocarcinoma | IRIS | 2004 |
| *cis*-1,2-Dichloroethene | | | | | | |
| Chloroform | 6.10E-03 | 3.05E-02 | $(mg/kg \times day)^{-1}$ | Colon, bladder, rectum, and liver carcinoma | IRIS | 2004 |
| Trichloroethene | 1.10E-02 | 7.33E-02 | $(mg/kg \times day)^{-1}$ | Liver and lung cancer | A provision value from EPA National Center for Environmental Assessment (NCEA). | |
| Vinyl chloride | 1.40E+00 | 1.40E+00 | $(mg/kg \times day)^{-1}$ | Liver, lung, digestive track, and brain tumors | IRIS | 2004 |

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**Table 3. Cancer Toxicity Data Summary for the SI BHHRA for Source Areas at Oil Landfarm, Building C-720 Areas, and the Storm Sewer (Continued)**

| Route: Inhalation | | | | | | | |
|---|---|---|---|---|---|---|---|
| **COPC[a]** | **Unit Risk[f]** | **Unit Risk Units** | **Inhalation Cancer Slope Factor[e]** | **Slope Factor Units** | **Weight of Evidence/Type of Cancers** | **Source[c]** | **Date Accessed** |
| 1,1-Dichloroethene | 5.00E-05 | $m^3/\mu g$ | 1.75E-01 | $(mg/kg \times day)^{-1}$ | Kidney, adenocarcinoma | IRIS | 2004 |
| *cis*-1,2-Dichloroethene | | | | | | | |
| Chloroform | 2.30E-05 | $m^3/\mu g$ | 8.05E-02 | $(mg/kg \times day)^{-1}$ | Colon, bladder, rectum, and liver carcinoma | IRIS | 2004 |
| Trichloroethene | 1.70E-06 | $m^3/\mu g$ | 6.00E-03 | $(mg/kg \times day)^{-1}$ | Liver and lung cancer | A provision value from EPA National Center for Environmental Assessment (NCEA). | |
| Vinyl chloride | 8.80E-05 | $m^3/\mu g$ | 3.08E-02 | $(mg/kg \times day)^{-1}$ | Liver, lung, digestive track, and brain tumors | IRIS | 2004 |

Note: Blank cells indicate that data are not available or are not appropriate.
[a] Volatile organic chemicals of potential concern (COPCs) are listed.
[b] The units for the oral slope factors are $(mg/kg \times day)^{-1}$ for nonradionuclides and Risk/pCi for radionuclides.
[c] Source codes are defined as follows:

a Source: *Integrated Risk Information System* (IRIS).
b Source: *Health Effects Assessment Summary Tables* (HEAST).
ex Value is extrapolated from the oral slope factor.
u The inhalation slope factor was calculated from inhalation unit risk as described in *RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance)* (November 1995).
v A provisional value provided to DOE's Oak Ridge Operations by EPA's Superfund Health Risk Technical Support Center.
w This value was withdrawn from IRIS or HEAST but is used in the assessment per guidance in the Risk Methods Document.
x A provision value from EPA National Center for Environmental Assessment (NCEA).

[e] The units for the inhalation slope factors are $(mg/kg \times day)^{-1}$ for nonradionuclides and Risk/pCi for radionuclides.
[f] The units for inhalation unit risks are $m^3/\mu g$.

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### Table 4. Toxicity Values for Chronic Exposure to Noncarcinogens via the Ingestion and Inhalation Exposure Routes

| COPC[a] | Oral Reference Dose[b] | Oral Reference Dose Source[c] | Inhalation Reference Dose[d] | Inhalation Reference Concentration[e] | Inhalation Reference Concentration Source[c] | RfD basis (vehicle)[f] | Target Organ Critical Effect[g] | Confidence Level[h] | Uncertainty Factor/Modifying Factor[i] |
|---|---|---|---|---|---|---|---|---|---|
| 1,1-Dichloroethene | 9.00E-03 | a | 9.00E-03 | 3.15E-02 | ex | LOAEL | Liver | Medium | (O)UF = 1000<br>(O)MF = 1 |
| *cis*-1,2-Dichloroethene | 1.00E-02 | b | 1.00E-02 | 3.49E-02 | ex | NOAEL | Blood | Low | (O)UF = 3000<br>(O)MF = 1 |
| Chloroform | 1.00E-02 | a | 8.75E-05 | 3.00E-04 | x | LOAEL | Liver | Medium | (O)UF = 1000<br>(O)MF = 1 |
| Trichloroethene | 6.00E-03 | v | 6.00E-03 | 2.09E-02 | ex | NA | Liver, kidney, CNS | NA | NA |
| Vinyl chloride | 3.00E-03 | a | 2.86E-02 | 1.00E-01 | a | (I)NOAEL/ LOAEL<br>(O)NOAEL/ LOAEL | Liver, kidney, CNS | Medium | (I)UF = 30<br>(I)MF = 1<br>(O)UF = 3<br>(I)MF = 1 |
| Tetrachloroethene | 1.00E-02 | a | 1.71E-01 | 6.00E-01 | v | (I)BMC<br>(O)NOAEL/ LOAEL | Kidney | (I)Medium<br>(O)Medium | (I)UF = 30<br>(I)MF = 1<br>(O)UF = 1000<br>(O)MF = 1 |

Notes: Blank cells indicate that data are not available or are not appropriate. NA=information not readily available at this time; GI=gastrointestinal; CNS=central nervous system; UF=uncertainty factor; MF = modifying factor
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
[a] Volatile organic COPCs are listed.
[b] The units for the oral reference doses are mg/(kg × day).
[c] Source codes are defined as follows:

a Source: *Integrated Risk Information System* (IRIS).
b Source: *Health Effects Assessment Summary Tables* (HEAST).
e Also see Soil Screening Guidance for Radionuclides: User's Guide.
ex Value is extrapolated from the oral reference dose.
u The inhalation slope factor was calculated from inhalation unit risk as described in *RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance)* (November 1995).
v A provisional value provided to DOE's Oak Ridge Operations by EPA's Superfund Health Risk Technical Support Center.
w This value was withdrawn from IRIS or HEAST but is used in the assessment per guidance in the Risk Methods Document.
x A provision value from EPA National Center for Environmental Assessment (NCEA).

[d] The units for the inhalation reference doses are mg/(kg × day).
[e] The units for the inhalation reference concentrations are mg/m$^3$.
[f] Or=oral; I=inhalation.
[g] GI = gastrointestinal tract; CNS=central nervous system.
[h] O = oral; I=inhalation; NA = not available.
[I] O = oral; I=inhalation; UF = uncertainty factor; MF = modifying factor; NA=not available.

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**Table 5. Toxicity Values for Chronic Exposure to Noncarcinogens via the Dermal Contact Exposure Route**

| COC | Oral Reference Dose[a] | GI Absorption Factor | Absorbed Reference Dose[b] |
|---|---|---|---|
| 1,1-Dichloroethene | 9.00E-03 | 1.00 | 9.00E-03 |
| *cis*-1,2-Dichloroethene | 1.00E-02 | 1.00 | 1.00E-02 |
| Chloroform | 1.00E-02 | 0.20 | 2.00E-03 |
| Trichloroethene | 6.00E-03 | 0.15 | 9.00E-04 |
| Vinyl Chloride | 3.00E-03 | 1.00 | 3.00E-03 |

[a] The units for the oral reference doses are mg/(kg × day).
[b] The units for the absorbed doses are mg/(kg × day). The absorbed reference doses are calculated by multiplying the administered reference dose by the gastrointestinal (GI) absorption factor; this value is used in the BHHRA to calculate contribution to systemic toxicity from dermal exposure.

The potential for noncarcinogenic effects (i.e., systemic toxicity or hazard) is evaluated by comparing an exposure level over a specific time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. The ratio of the dose estimate to the RfD is called an HQ. An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from the chemical are unlikely. An HI < 1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely.

The HQ is calculated as follows:

$$\text{Non-cancer } HQ = CDI / RfD$$

where: CDI = chronic daily intake or dose,
RfD = reference dose.

The CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term). EPA does not have a target range for hazard; however, cumulative HI values less than the threshold value of 1 are deemed to be acceptable.

Observations of the SI BHHRA for the VOC COCs are presented here. Consistent with current and likely future land use, observations for source areas focus on risks posed under industrial land use. Similarly, observations for off-site areas focus on risks from use of groundwater at the PGDP property boundary, the first location where future residential use is possible.

Tables 6 through 9 present the results of risk characterization for the VOC sources at the C-747-C Oil Landfarm, C-720 Building areas, and the storm sewer.

**Table 6. Summary of Risk Characterization for Volatile Organic Compound Chemicals of Concern for the Oil Landfarm, C-720 Building Areas, and the Storm Sewer**

| **Scenario Time frame: Future** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Receptor Population: Off-site rural resident** | | | | | | | |
| **Receptor Age: Child and Adult (Lifetime)** | | | | | | | |
| **Excess Lifetime Cancer Risk** | | | | | | | |
| **Medium** | **Exposure Medium** | **Point of Exposure (POE)** | **Chemical of Concern** | **Ingestion** | **Inhalation** | **Dermal** | **Exposure Routes Total Risk** |
| Groundwater | Groundwater | Oil Landfarm | 1,1-Dichloroethene | 8E-06 | 7E-06 | 1E-07 | 1E-05 |
| | | | Chloroform | 4E-07 | 1E-05 | 3E-08 | 1E-05 |
| | | | Trichloroethene | 2E-04 | 3E-04 | 3E-05 | 5E-04 |
| | | | | | | **Oil Landfarm Groundwater Total Risk =** | **5E-04** |
| Groundwater | Groundwater | C-720 Building areas | 1,1-Dichloroethene | 6E-04 | 5E-04 | 9E-06 | 1E-03 |
| | | | Trichloroethene | 2E-04 | 3E-04 | 3E-05 | 5E-04 |
| | | | Vinyl chloride | 6E-05 | 3E-05 | 7E-07 | 9E-05 |
| | | | | | | **C-720 Building Areas Groundwater Total Risk =** | **2E-03** |
| Groundwater | Groundwater | Storm Sewer | 1,1-Dichloroethene | 1E-06 | 1E-06 | 1E-08 | 2E-06 |
| | | | Trichloroethene | 2E-06 | 3E-06 | 4E-07 | 6E-06 |
| | | | | | | **Storm Sewer Groundwater Total Risk =** | **8E-06** |

**Table 7. Hazard Characterization Summary for Volatile Organic Compound Chemicals of Concern for the Oil Landfarm, C-720 Building Areas, and the Storm Sewer**

| Scenario Time frame: Future | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Receptor Population: Off-site rural resident** | | | | | | | | |
| **Receptor Age: Child** | | | | | | | | |
| **Medium** | **Exposure Medium** | **Point of Exposure (POE)** | **Chemical of Concern** | **Primary Target Organ** | **Ingestion** | **Inhalation** | **Dermal** | **Exposure Routes Total HI** |
| Groundwater | Groundwater | Oil Landfarm | 1,1-Dichloroethene | Liver | 5E-03 | 2E-02 | 7E-05 | 3E-02 |
| | | | Chloroform | Liver | 2E-02 | 1E+01 | 1E-03 | 1E+01 |
| | | | Trichloroethene | Liver | 9E+00 | 6E+01 | 1E+00 | 7E+01 |
| | | | *cis*-1,2-Dichloroethene | Blood | 4E-01 | 2E+00 | 6E-03 | 3E+00 |
| | | | | | | | **Oil Landfarm Groundwater Total HI =** | **8E+01** |
| Groundwater | Groundwater | C-720 Building areas | 1,1-Dichloroethene | Liver | 4E-01 | 2E+00 | 5E-03 | 2E+00 |
| | | | Trichloroethene | Liver | 8E+00 | 6E+01 | 1E+00 | 7E+01 |
| | | | Vinyl chloride | Liver, kidney, Central Nervous System | 5E-02 | 4E-01 | 5E-04 | 4E-01 |
| | | | *cis*-1,2-Dichloroethene | Blood | 2E-01 | 1E-00 | 3E-03 | 1E+00 |
| | | | *trans*-1,2-Dichloroethene | Blood | 5E-02 | 3E-01 | 7E-05 | 3E-01 |
| | | | | | | | **C-720 Building Areas Groundwater Total HI =** | **7E+01** |
| Groundwater | Groundwater | Storm Sewer | 1,1-Dichloroethene | Liver | 7E-04 | 7E-03 | 9E-04 | 4E-03 |
| | | | Trichloroethene | Liver | 1E-01 | 5E-01 | 2E-02 | 6E-01 |
| | | | | | | | **Storm Sewer Groundwater Total HI =** | **6E-01** |

HI = hazard index

**Table 8. HIs at POEs at the Plant Boundary, Property Boundary, and near the Ohio River for Household Use of Groundwater Water Contaminated by COPC Migration from the C-720 Building Area, and Oil Landfarm**

| | HI (child) at POE | | | HI (adult) at POE | | |
|---|---|---|---|---|---|---|
| **COPC[a]** | **Plant Boundary** | **Property Boundary** | **Near Ohio River** | **Plant Boundary** | **Property Boundary** | **Near Ohio River** |
| *C-720 Building area Variable Degradation Scenario* | | | | | | |
| Trichloroethene | 1.18E-01 | < 0.1 | < 0.1 | 2.99E-02 | < 0.1 | < 0.1 |
| *cis*-1,2-Dichloroethene | 1.17E-01 | 7.69E-02 | NR | 2.88E-02 | 1.89E-02 | NR |
| *trans*-1,2-Dichloroethene | 2.74E-03 | 1.28E-03 | NR | 6.70E-04 | 3.13E-04 | NR |
| Vinyl chloride | 2.61E-03 | 1.31E-03 | NR | 9.13E-04 | 4.57E-04 | NR |
| **Total HI[b]** | **2.40E-01** | **1.79E-01** | < 0.1 | **6.03E-02** | **1.20E-01** | < 0.1 |
| *C-720 Building area Fixed Degradation Scenario* | | | | | | |
| Trichloroethene | 4.04E-01 | 1.76E-01 | < 0.1 | 1.02E-01 | 4.43E-02 | < 0.1 |
| *cis*-1,2-Dichloroethene | 1.17E-01 | 7.69E-02 | NR | 2.88E-02 | 1.89E-02 | NR |
| *trans*-1,2-Dichloroethene | 2.74E-03 | 1.28E-03 | NR | 6.70E-04 | 3.13E-04 | NR |
| Vinyl chloride | 2.61E-03 | 1.31E-03 | NR | 9.13E-04 | 4.57E-04 | NR |
| **Total HI[b]** | 5.26E-01 | 2.56E-01 | < 0.1 | **1.32E-01** | **< 0.1** | **< 0.1** |
| *Oil Landfarm—Variable Degradation Scenario* | | | | | | |
| Trichloroethene | 6.18E+00 | 2.23E-01 | < 0.1 | 1.56E+00 | 5.46E-02 | < 0.1 |
| *cis*-1,2-Dichloroethene | 5.90E-01 | 1.14E-01 | NR | 1.45E-01 | 2.79E-02 | NR |
| *trans*-1,2-Dichloroethene | 3.72E-01 | 6.57E-02 | NR | 9.11E-02 | 1.61E-02 | NR |
| Vinyl chloride | 5.23E-03 | 9.80E-04 | NR | 1.83E-03 | 3.42E-04 | NR |
| **Total HI[b]** | **7.15E+00** | **4.04E-01** | **<0.1** | **1.80E+00** | **9.89E-02** | **< 0.1** |
| *Oil Landfarm—Fixed Degradation Scenario* | | | | | | |
| Trichloroethene | 4.62E+00 | 7.73E-01 | < 0.1 | 1.17E+00 | 1.95E-01 | < 0.1 |
| *cis*-1,2-Dichloroethene | 5.90E-01 | 1.14E-01 | NR | 1.45E-01 | 2.79E-02 | NR |
| *trans*-1,2-Dichloroethene | 3.72E-01 | 6.57E-02 | NR | 9.11E-02 | 1.61E-02 | NR |
| Vinyl chloride | 5.23E-03 | 9.80E-04 | NR | 1.83E-03 | 3.42E-04 | NR |
| **Total HI[b]** | 5.59E+00 | 9.54E-01 | **< 0.1** | 1.41E+00 | 2.39E-01 | < 0.1 |

COPC = chemical of potential concern
NR = no modeling result available.
POE = point of exposure
HI = hazard index
[a] *Results for TCE are from probabilistic modeling, other COPC results from deterministic evaluation.*
[b] Total HIs are calculated by summing chemical-specific HIs derived using maximum concentrations because all COPCs are expected to reach their maximum concentration at the POEs at approximately the same time.

**Table 9. ELCRs at POEs at the Plant Boundary, Property Boundary, and near the Ohio River for Household Use of Groundwater Water Contaminated by COPC Migration from the C-720 Building Area, and Oil Landfarm**

| | ELCR at POE | | |
|---|---|---|---|
| **COPC**[a] | **Plant Boundary** | **Property Boundary** | **Near Ohio River** |
| *C-720 Building area—Variable Degradation Scenario* | | | |
| Trichloroethene | 2.72E-07 | < 1.00E-06 | < 1.00E-06 |
| Vinyl chloride | 2.29E-06 | 1.14E-06 | NR |
| **Total ELCR**[b] | 2.56E-06 | 1.14E-06 | < 1.00E-06 |
| *C-720 Building area—Fixed Degradation Scenario* | | | |
| Trichloroethene | 3.14E-06 | 1.2E-06 | < 1.00E-06 |
| Vinyl chloride | 2.29E-06 | 1.14E-06 | NR |
| **Total ELCR**[b] | 5.43E-06 | 2.34E-06 | < 1.00E-06 |
| *Oil Landfarm (SWMU 1)—Variable Degradation Scenario* | | | |
| Trichloroethene | 1.45E-05 | 5.49E-07 | < 1.00E-06 |
| Vinyl chloride | 4.57E-06 | 8.57E-07 | NR |
| **Total ELCR**[b] | 1.91E-05 | 1.41E-06 | < 1.00E-06 |
| *Oil Landfarm (SWMU 1)—Fixed Degradation Scenario* | | | |
| Trichloroethene | 3.88E-05 | 5.32E-06 | 1.25E-07 |
| Vinyl chloride | 4.57E-06 | 8.57E-07 | NR |
| **Total ELCR**[b] | 4.34E-05 | 6.18E-06 | 1.25E-07 |

COPC = chemical of potential concern
ELCR = excess lifetime cancer risk
HI = hazard index
NC = not a carcinogen; NR = no modeling result available
POE = point of exposure
[a] *Results for TCE are from probabilistic modeling, other COPC results from deterministic evaluation.*
[b] Total ELCRs are calculated by summing chemical-specific ELCRs derived using maximum concentrations because all COPCs are expected to reach their maximum concentration at the POEs at approximately the same time.

The hypothetical rural residential use of groundwater scenario is of concern for both ELCR and HI at each source area, except the Storm Sewer, which is of concern for ELCR only.

The risk assessment contained in the Southwest Plume SI provides a complete summary of the risk analysis associated with the SWMUs (DOE 2007). For the hypothetical rural resident at the C-747-C Oil Landfarm, VOC COCs include chloroform; *cis*-1,2-DCE; 1,1-DCE; and TCE. All except 1,1-DCE are "Priority COCs" (i.e., chemical specific HI or ELCR greater than or equal to 1 or $1 \times 10^{-4}$). The VOCs make up 78% of a cumulative ELCR of $6 \times 10^{-4}$ and 76% of a cumulative HI of 26. For the hypothetical rural child resident at the C-747-C Oil Landfarm, VOC COCs include chloroform; *cis*-1,2-DCE; and TCE, all of which are "Priority COCs" that make up 85% of the cumulative HI of 99.

At the C-720 Building Area, the VOC COCs for groundwater use by the hypothetical rural resident include TCE; *cis*-1,2-DCE; VC; and 1,1-DCE, with all except VC being "Priority COCs." The VOCs make up 93% of a cumulative ELCR of $1.8 \times 10^{-3}$ and 57% of the cumulative HI of 23. For groundwater use by the hypothetical rural child resident, VOC COCs include TCE; *cis*-1,2-DCE; *trans*-1,2-DCE; and 1,1-DCE, all of which are "Priority COCs," except for *trans*-1,2-DCE. The VOCs make up 76% of a cumulative HI of 102.

At the Storm Sewer, the rural residential COCs include TCE and 1,1-DCE, neither of which is a "Priority COC." The VOCs make up 100% of a cumulative ELCR of $7.9 \times 10^{-6}$. The HI for the storm sewer was less than 1 and, therefore, not of concern. For groundwater use by the hypothetical child resident, VOC COCs include TCE and 1,1-DCE, neither of which is a "Priority COC." The VOCs make up 100% of a cumulative HI of 0.6 for the child hypothetical resident. The Southwest Plume SI concluded the Storm Sewer is not a source of VOC contamination and requires no remediation.

At the property boundary for the rural resident, the migrating COCs from the C-747-C Oil Landfarm are TCE and VC with no "Priority COCs." The VOCs make up 100% of the total ELCR of $1.4 \times 10^{-6}$ with variable degradation and $6.1 \times 10^{-6}$ with fixed degradation and the HI for the rural child resident is less than 1.0 under both degradation scenarios. The COC migrating from the C-720 Building Area to the rural resident at the property boundary is VC, which is not a "Priority COC." The VC makes up greater than 95% of the total ELCR of $1.1 \times 10^{-6}$ with variable degradation and $2.34 \times 10^{-6}$ with fixed degradation and the HI for the rural child resident is less than 0.3 under both degradation scenarios. Based on results of previous and current modeling reported in the SI BHHRA, neither metals nor radionuclides are COCs for contaminant migration from the C-747-C Oil Landfarm or C-720 Building Area.

Vapor transport modeling was conducted in the Southwest Plume SI to evaluate the potential air concentrations in a residential basement from soil contamination at the C-747-C Oil Landfarm and the C-720 Building Area. The results of the vapor transport model were used as the predicted household air concentrations for estimating ELCR and hazard for the adult rural resident. The vapor hazard and cancer risk at the C-747-C Oil Landfarm were 4.8 and 7.8E-05, respectively. At C-720 Building Area, the vapor hazard was 0.7, and the vapor cancer risk was 4.0E-05.

### 2.7.2 Summary of Ecological Risk Assessment

The screening ecological risk assessment, which used results taken from the baseline ecological risk assessment completed as part of the WAG 27 RI (DOE 1999a), concluded that a lack of suitable habitat in the industrial setting at the C-747-C Oil Landfarm and the C-720 Building Area precluded exposures of ecological receptors under current conditions; therefore, it was determined during problem formulation that an assessment of potential risks under current conditions was unnecessary. Additionally, groundwater flow modeling predicted the first location that TCE in groundwater from the Oil Landfarm and the C-720 Building could discharge is approximately 6.4 km (4.0 miles) away, near the Ohio River.

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from this site that may present an imminent and substantial endangerment to public health or welfare.

## 2.8 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific or OU-specific goals for protecting human health and the environment (EPA 1988). RAOs provide an indication or an expectation of what the RA will accomplish. The RAOs are developed by taking into account the results of the PGDP SMP goals, risk assessment results, and ARARs. The following RAOs for the Southwest Plume were developed by a working group comprised of the PGDP FFA signatories, which include DOE, EPA, and the Commonwealth of Kentucky:

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

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

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

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

Worker protection remediation goals (RGs) are VOC concentrations in soils present at depths of 0-10 ft that would meet RAO 2a with no other controls necessary. Worker protection RGs were obtained from the Action Levels for the excavation worker stated in Appendix, Table A.4, of the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky* (DOE 2011e). Worker protection RGs for VOCs in the source areas at levels of protection ranging from ELCR of 1E-04 to 1E-06, and HIs of 1E-01 to 3 are provided in Table 10.

Consistent with the FFS, the treatment zone in this ROD encompasses the soils directly below and within the boundaries of the C-747-C Oil Landfarm and C-720 Northeast and Southeast Sites. Soil protection RGs are VOC concentrations in subsurface soils in the treatment zone that would not result in exceedance of the MCLs in the RGA, which would meet RAO 3 with no other controls necessary. The treatment zones or subsurface soil areas where the RGs will be met are shown in Figures 1 and 2 for the C-747-C Oil Landfarm and C-720 Northeast and Southeast Sites, respectively.

The groundwater protection RGs are provided in Table 11. The RGs were calculated for TCE half-lives in UCRS soils ranging from 5 years to 50 years to assess the effects of high to low rates of degradation on overall remedy time frames (50 years essentially representing no observable degradation). Other VOCs were assumed not to be degraded.

**Table 10. Worker Protection RGs for VOCs at the C-720 Area and the Oil Landfarm Source Areas, mg/kg[a]**

| VOC | ELCR 1E-06 | ELCR 1E-05 | ELCR 1E-04 | HI = 0.1 | HI = 1.0 | HI =3.0 |
|---|---|---|---|---|---|---|
| TCE | 5.85E-02 | 5.85E-01 | 5.85E+00 | 1.93 | 19.3 | 57.9 |
| 1,1-DCE | 6.26E-02 | 6.26E-01 | 6.26E+00 | 25 | 250 | 750 |
| *cis*-1,2-DCE | NV | NV | NV | 8.94 | 89.4 | 268.2 |
| *trans*-1,2-DCE | NV | NV | NV | 11.70 | 117 | 351 |
| Vinyl chloride | 1.10E-01 | 1.10E+00 | 1.10E+01 | 8 | 80 | 240 |

[a] Shaded RG values exceed the average concentration reported in Revised FFS, Appendix C for the 0-10 ft interval at the Oil Landfarm and the C-720 Area.
RG units are mg/kg
RG = remediation goal
ELCR = excess lifetime cancer risk
HI = hazard index
NV = no value

**Table 11. Groundwater Protection RGs for VOCs at the C-720 Area and the Oil Landfarm Source Areas**

| VOC | Half-Life (yr) | Primary MCL (mg/L) | UCRS Soil RG (mg/kg)[a] |
|---|---|---|---|
| C-720 Northeast and Southeast Sites | | | |
| TCE | 5 | 5.00E-03 | 9.20E-02 |
| TCE | 25 | 5.00E-03 | 8.30E-02 |
| TCE | 50 | 5.00E-03 | 7.50E-02 |
| 1,1-DCE | infinite | 7.00E-03 | 1.37E-01 |
| *cis*-1,2-DCE | infinite | 7.00E-02 | 6.19E-01 |
| *trans*-1,2-DCE | infinite | 1.00E-01 | 5.29E+00 |
| Vinyl chloride | infinite | 2.00E-03 | 5.70E-01 |
| Oil Landfarm | | | |
| TCE | 5 | 5.00E-03 | 8.50E-02 |
| TCE | 25 | 5.00E-03 | 8.00E-02 |
| TCE | 50 | 5.00E-03 | 7.30E-02 |
| 1,1-DCE | infinite | 7.00E-03 | 1.30E-01 |
| *cis*-1,2-DCE | infinite | 7.00E-02 | 6.00E-01 |
| *trans*-1,2-DCE | infinite | 1.00E-01 | 1.08E+00 |
| Vinyl chloride | infinite | 2.00E-03 | 3.40E-02 |

[a] Based on a dilution attenuation factor of 59

The selected remedial action for the Oil Landfarm would achieve RAOs by removing significant amounts of TCE and VOCs in the subsurface soils by treatment using deep soil mixing and *in situ* chemical treatment. A FC/RDSI will be performed at the C-720 Building (SWMUs 211-A and 211-B) to determine if the extent and magnitude of contamination present in the subsurface soils warrants treatment. Based on the results of the FC/RDSI, either *In Situ* Source Treatment using EISB with Interim LUCs or Long-term Monitoring with Interim LUCs will be implemented. Both of these actions will meet the RAOs. EISB, if selected, will meet RAOs by removing the subsurface contamination using biological treatment. Long-term Monitoring, if selected would meet all applicable ROAs. Each of the remedial alternatives results in a decrease in the amount of mass available for migration to the RGA.

## 2.9 DESCRIPTION OF ALTERNATIVES

The following eight remedial alternatives were assessed for application in the source zones comprised of TCE and other VOCs in the UCRS at the C-747-C Oil Landfarm and C-720 Northeast and Southeast Sites. Due to infrastructure interferences, geological field conditions, and requirements for applying the alternatives, not all alternatives are applicable to the three source areas. Only Alternatives 2, 5, and 8 would be implemented at all three source areas. The applicability matrix, Table 12, further identifies the alternatives and source area associations. Alternative 8 was not evaluated for the source zones at SWMUs 211-A and 211-B in the Revised FFS due to the presence of infrastructure near the C-720 Building. Subsequent to the final evaluation, however, DOE has determined that EISB will be applicable to this SWMU using pressure injection methods as opposed to gravity injection and infiltration, which was evaluated in the Revised FFS.

**Table 12. Alternative Application Matrix**

| Alternative | C-720-NE (211-A) | C-720-SE (211-B) | Oil Landfarm |
|---|---|---|---|
| 1 | | | |
| 2 | X | X | X |
| 3 | | | X |
| 4 | | | X |
| 5 | X | X | X |
| 6 | X | X | |
| 7 | X | X | |
| 8 | X | X | X |

The evaluated alternatives included components that were specific to the alternative and some that were common to a number of the alternatives. The common components are as follows:

- Interim LUCs with warning signs and the excavation/penetration permit (E/PP) program, and
- Groundwater monitoring.

Because each remedy will result in hazardous substances remaining on-site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory five-year review under CERCLA Section 121(c) will be conducted until the levels of COCs allow for unlimited use and unrestricted exposures of the soil and groundwater. The five-year reviews will be conducted to ensure that the remedy is or will be protective of human health and the environment. The statutory reviews will be conducted in accordance with CERCLA 121(c), the NCP at 40 *CFR* § 300.430(f)(4)(ii), and EPA guidance and are not a component of the eight alternatives.

### 2.9.1 Detailed Alternative Components

The following provides a description of the non-common components that make up the eight alternatives.

- **Alternative 1: No Further Action.** Formulation of a no action (No Further Action) alternative is required by the NCP [40 *CFR* § 300.430(e)(6)] and CERCLA FS guidance (EPA 1988). The no action alternative serves as a baseline for evaluation of other remedial action alternatives and is generally retained throughout the FS process. As defined in CERCLA guidance (EPA 1988), a no action alternative may include environmental monitoring; however, other actions taken to reduce exposure, such as site fencing, are not included as a component of the no action alternative. Alternative 1, therefore, includes no actions and no costs.

- **Alternative 2: Long-term Monitoring with Interim LUCs.** This alternative consists of groundwater monitoring and interim LUCs. It will not include an RDSI, treatment, or removal of VOC contamination. Alternative 2 would prevent the completion of exposure pathways. Alternative 2 is applicable to all three source areas and would have a total escalated project cost of $9.3M and a present worth cost of $5.6M. The estimated time to attain RGs at SWMU 1 and C-720 is estimated at >100 and 97 years, respectively.

- **Alternative 3: *In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs.** This alternative consists of an RDSI to refine the extent of VOC contamination and quantify parameters for selecting and applying treatment reagents. The extent and distribution of VOCs in the UCRS would impact the spacing/locations and depths of the augered areas. The amount and type of reagent chosen would be based on RDSI sampling results. The VOC contamination would be treated using large diameter augers to mix the soil with a chemical reagent to destroy the VOC contamination. Amendment will be added from approximately 15 ft bgs to the lowest depth of VOC contamination (but no closer than within 10 ft of the UCRS/RGA contact). As the auger is advanced into the soil, a slurry would be pumped through the hollow stem of the shaft and injected into the soil at the tip. The auger would be rotated and raised and the mixing blades on the shaft would blend the soil and the slurry. When the design depth is reached, the auger would be withdrawn, and the mixing process would be repeated on the way back to the surface. This mixing technique would be repeated, as necessary, in each boring.

Contaminated portions of the UCRS would be treated using a two-phase treatment process. In the first phase, a reagent slurry (which could include iron filings, chemical reagent, biopolymer guar, water grout slurry and/or steam) would be mixed in the soil columns below 15 ft bgs. In the second phase, a bentonite and water solution would be mixed with the columns below 10 ft bgs to stabilize the mixing column and immobilize potential residual contamination. In addition, the top 10 ft bgs would be injected, as needed, with a cement/bentonite slurry. The cement/bentonite mixture would stabilize, improve the strength of, and reduce the compressibility of the treated area. Variable amounts of infiltration would be expected, based on the final design of the cement cap. If no cement/grout mixture were injected, the surface likely would be unstable following treatment.

Also included in the alternative would be confirmation sampling, waste management, and site restoration activities. Confirmatory sampling in the treatment area would be required to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during Remedial Action Work Plan (RAWP) development. The addition of material to the subsurface during the augering will cause expansion of *in situ* material during deep soil mixing. This expansion could result in the generation of secondary waste spoils (e.g., soil, reagent, grout, and water mixture). On average, the quantity of spoils generated is approximately 30% of the volume of the treated column; however, up to 60% potentially could be generated. Soils and groundwater containing TCE are considered a RCRA listed hazardous waste until the materials can be characterized further. It was assumed that all wastes would be managed as nonhazardous because the TCE hazardous constituent would be treated during implementation of the remedial action. Actual disposal requirements would be determined by sampling of secondary wastes. All secondary wastes would be managed in accordance with ARARs. Surface restoration following this remedial action would include placement of topsoil and vegetation at the Oil Landfarm. The site would be graded to promote runoff, and a land survey would be conducted to produce topographic as-built drawings.

Alternative 3 is applicable only to SWMU 1 (Oil Landfarm) and would have a total escalated project cost of $11.9M and a present worth cost of $10.3M. The estimated time to attain RGs is 68 years.

- **Alternative 4: Source Removal and *In Situ* Chemical Source Treatment with Interim LUCs.** This alternative includes an RDSI for source area refinement. The RDSI would be performed at the Oil Landfarm to determine better the extent and distribution of VOCs, including potential DNAPL TCE, and to determine UCRS soil and groundwater parameters specific to the reagent used, as necessary, in the excavation buffer zone. The excavation of the sources would be performed using a drilling rig equipped with a large diameter (6-ft) solid-stem auger (LDA). Due to the transmissive nature of the RGA directly below the UCRS, heaving in the borehole potentially could occur. To prevent heaving during excavation, a buffer zone of approximately 10 ft would be maintained between the borings and the top of the RGA, which is completely saturated. The spacing and locations of the borings would be designed to remove 100% of contaminated soils above the excavation buffer zone. Following excavation, an amendment would be added, as necessary, to the excavation buffer zone to treat this area. The amendment would be placed in the bottom of the completed boring and allowed to infiltrate the lower UCRS soils over time. The borehole would be filled with permeable flowable fill material to allow recharge through the area. Recharge will assist the percolation of the amendment placed into the bottom of the completed borings to treat contamination present in the excavation buffer zone.

The excavated soils would be managed and disposed of according to ARARs. A management plan would be included in the Remedial Design (RD)/RAWP for the handling, stockpiling, and segregation of the excavated soils and other generated waste materials. Confirmatory sampling and analysis of treated soils in the excavation buffer zone for VOCs would be required following completion of the *in situ* treatment phase of the remedial action. Samples also may be collected from clean backfill material to confirm soil characteristics are appropriate for use during the remedial action. A confirmatory sampling plan would be prepared during RAWP development. Surface restoration associated with this remedial action would include the addition of topsoil and vegetation at the Oil Landfarm. The site would be graded to promote runoff and surveyed for final as-built drawings.

Alternative 4 is applicable only to SWMU 1 (Oil Landfarm) and would have a total escalated project cost of $28.3M and a present worth cost of $25.8M. The estimated time to attain RGs is 38 years.

- **Alternative 5: *In Situ* Thermal Treatment with Interim LUCs.** Alternative 5 includes an RDSI investigation at the Oil Landfarm and the C-720 Northeast and Southeast Sites to bound and confirm the extent of VOCs and potential DNAPL TCE and to close data needs concerning the areal and vertical extent of contamination and the mass of VOC contamination present in the UCRS. Based on the calculated RGs for VOC concentrations in source area soil, supplemental investigations to delineate the lateral and vertical extent of VOC contamination at the source areas would be completed. The RDSI would be based on a systematically planned approach. The conceptual design for the RDSI includes these elements:

  — Preliminary soil gas sampling using the MIP and on-site analysis for VOCs at the Oil Landfarm and C-720 Area Northeast and Southeast Sites to bound and confirm the areal and vertical extent of contamination including potential DNAPL; and

  — Soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent at locations that have been identified using the MIP results. Soil cores also would be evaluated to determine the presence or absence of DNAPL.

ERH uses electrodes strategically placed into the contaminated zone in a pattern to match the characteristics of the electrical power being utilized to heat the soil. Also, the characteristics of the soil such as heat transfer, permeability, and fluid content and saturation, as well as thermal computer models, are used to design the treatment system and the equipment utilized to deliver the power to the subsurface. The ERH treatment system conceptual design, pending RDSI results and incorporation of all lessons learned from implementing the C-400 Building Interim Remedial Action, for the three Southwest Plume source areas includes the following:

- 272 total electrodes
- 68 electrode wells
- 24 UCRS wells
- 8 contingency wells
- 6 digital thermocouple temperature monitoring wells
- 18 vacuum monitoring/digital thermocouple temperature monitoring wells
- Well field piping
- Recovery of TCE from vapor using granular activated carbon (GAC) and off-site regeneration

The electrodes are arranged so that the contaminated volume of soil is contained inside the periphery of the electrodes. The vapor extraction wells are located within the contaminated soil. The position of the extraction wells relative to the electrodes is determined so that heat transfer by convection within the porous soil is maximized, thus minimizing heat losses and increasing the uniformity of the temperature distribution.

A conventional water handling and vapor recovery system is installed as part of the process. The water circulation system provides water to the electrode wells to prevent overheating and soil resistivity characteristics. The electrode wells are designed with fluid injection capability; therefore, some of the injected water flows from the electrode wells toward the vapor extraction wells. The heat transported by fluid movement tends to heat the soil rapidly and uniformly. The produced fluids increase with temperature over time. These fluids are reinjected and the overall thermal efficiency is improved. The electrical current path is shared between the electrodes passing through the connate water in the porous soil. The installation and treatment period is estimated at approximately one year. System shutdown criteria would be established in the RD. TCE would be recovered from the vapor phase extracted from the subsurface on GAC and shipped for off-site regeneration or disposal, depending on GAC characterization results. TCE vapor waste stream concentrations would be measured daily at the influent of the primary GAC vessel using a photo acoustic analyzer. The vapor waste stream velocity also would be measured daily using a handheld flow meter. The resulting measurements would be used to calculate the approximate TCE loading and mass removal rate for each GAC vessel. Air samples and water samples of produced water would be sent off-site for laboratory analysis. Subsurface temperatures and electrical usage would be monitored by the vendor.

Confirmatory sampling in the treatment area would be required to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during RAWP development. The conceptual design for confirmatory sampling includes soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent. Depths and locations of cores would be determined based on the results of the RDSI.

Secondary wastes generated by the remedial action would include vapor, spent GAC, drill cuttings (produced during installation of electrodes and vapor recovery wells), personal protective equipment (PPE), and decontamination fluids. Dispositioning requirements would be determined by sampling of containerized soils. All secondary wastes would be managed in accordance with all ARARs.

Site restoration activities would include demobilizing and removing all RDSI equipment; sealing all MIP and soil coring locations with bentonite; reseeding disturbed vegetated areas at the Oil Landfarm and the C-720 Northeast Site; and repairing penetrations of asphalt and concrete at the C-720 Northeast and Southeast Sites. ERH equipment would be removed from vapor recovery wells to the extent feasible and the electrode and vacuum extraction wells abandoned in place.

Alternative 5 is applicable to all three source areas and would have a total escalated project cost of $44.6M and a present worth cost of $39.1M. The estimated time to attain RGs is 39 and 20 years for SWMU 1 and the C-720 SWMUs, respectively.

- **Alternative 6: *In Situ* Source Treatment Using Liquid Atomized Injection with Interim LUCs.** An RDSI would be performed at the C-720 Northeast and Southeast Sites to delineate better the extent of VOCs and potential DNAPL TCE and to close any data needs concerning the areal and vertical extent of contamination. Based on the calculated RGs for VOC concentrations in source area soil, supplemental investigations to delineate the lateral and vertical extent of VOC contamination at the source areas would be completed. The conceptual design for the RDSI includes these elements:

¾ Preliminary soil gas sampling using the MIP and on-site analysis for VOCs at the C-720 Area Northeast and Southeast Sites to estimate the areal and vertical extent of contamination including potential DNAPL;

¾ Soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent at locations that have been identified using the MIP results. Soil cores also would be evaluated to determine the presence or absence of DNAPL;

¾ Field-scale testing to determine typical propagation distances in the subsurface and the appropriate reagent mixture to be added during the Liquid Atomized Injection (LAI) process; and

¾ Civil survey of all sampling locations.

The treatment by LAI will be performed at C-720 Northeast and Southeast Sites. The treatment will take into account the considerations necessary for implementation at the C-720 Northeast or Southeast Sites. These considerations include the type of reagent, dosage of reagent necessary, by-products of treatment, utility locations, foundation locations, and radius of influence. The treatment phase of this remedial alternative would consist of a high pressure injection of an aerosolized reagent. LAI would be implemented using a direct-push rig to create a temporary 4-inch borehole. A reagent would be mixed on the surface and introduced into a high-flow, high-velocity gas stream (non-flammable) at the well head. No polymers, guar, or other suspension fluids are required. The LAI equipment would allow the amendment to be mixed uniformly with potable water and fed into a high velocity nitrogen gas stream, which would be directed down the hole and radially outward from the injection location. Using a direct push drilling method, a casing would be advanced to the bottom of the injection zone (approximately 50 to 60 ft bgs) to prevent borehole collapse and to facilitate deployment of the down-hole injection assembly. Once the casing was in place, the injection tooling would be lowered into the casing. The casing would be retracted upward to expose the injection assembly to the formation. Reagent injections would take place after isolation packers are inflated to the appropriate pressure. Depending upon the specific characteristics of the soils surrounding the injection locations, either a single, double, or triple packer system may be used. The injection configuration could be adjusted in the field, as needed. The injection would be initiated by the introduction of pressurized gas for 10 to 15 seconds either to fluidize or to fracture the formation and to establish flow. The reagent slurry then would be pumped into the pressurized nitrogen gas stream at the well-head and become atomized prior to dispersion into the formation. Once the injection was complete at that interval, the packers would be deflated, and the outer casing and injection assembly would be retracted upward (approximately 3.5 to 4 ft) to the next injection interval. This process would be repeated until the entire treatment zone was addressed at that location. The emplacement of reagent would be governed by the flow of gas in the fractures and around the soil particles, and the particles would settle as the kinetic energy decreased.

Secondary waste potentially could be generated if reagent were to daylight to the surface through vertical fractures created during the LAI process. Approximately 1-2 drums of waste could be expected for a project the size of the C-720 Northeast and Southeast Sites. Wastes would be sampled and disposed of at an appropriate on-site or off-site disposal facility. All secondary wastes would be managed in accordance with all ARARs.

Confirmatory sampling in the treatment area would be required to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during RAWP development. Site restoration activities prior to remedy completion would include demobilizing and removing all RDSI equipment, sealing all MIP, soil coring, and DPT borehole locations with bentonite, reseeding disturbed vegetated areas at the C-720 Northeast Site, and repairing penetrations of asphalt and concrete at the C-720 Northeast and Southeast Sites.

Alternative 6 is applicable only to the C-720 Building Northeast (SWMU 211-A) and Southeast (SWMU 211-B) source areas. The total escalated project cost and present worth cost for Alternative 6 are $11.1M and $8.2M, respectively. The estimated time to attain RGs is 52 years.

- **Alternative 7: *In Situ* Soil Flushing and Source Treatment Using Multiphase Extraction with Interim LUCs.** An RDSI would be performed at the C-720 Northeast and Southeast Sites to delineate more fully the extent of VOCs and DNAPL TCE and to close any data needs concerning the areal and vertical extent of contamination. Based on the calculated RGs for VOC concentrations in source area soil presented in Section 2.2, supplemental investigations to delineate the lateral and vertical extent of VOC contamination at the source areas would be completed as described for Alternative 3. The RDSI would be based on a systematically planned approach. The conceptual design for the RDSI includes these elements:

¾ Preliminary soil gas sampling using the MIP and on-site analysis for VOCs at the C-720 Area Northeast and Southeast Sites to estimate the areal and vertical extent of contamination including potential DNAPL.

¾ Soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent at locations that have been identified using the MIP results. Soil cores also would be evaluated to determine the presence or absence of DNAPL.

¾ Installation of dedicated soil gas monitoring points using DPT and sampling and analysis for VOCs. Dedicated soil gas monitoring points would be used to monitor air pressure and vapor concentrations during multiphase extraction.

¾ Civil survey of all sampling locations.

Also in the RDSI, air permeability testing for each site, as needed, will be performed. The information available from the C-400 Interim Remedial Action may be sufficient when complete to support design. Air permeability testing would consist of installing at least one 4-inch vapor extraction well and applying vacuum using a skid-mounted blower and off-gas treatment system. Air pressure would be monitored using transducers or pressure gauges installed on the dedicated soil gas monitoring points or additional 10.16-cm (4-inch) wells. The radial pressure distribution observed in the air permeability test would be used to determine the required venting well spacing.

Multiphase extraction will be combined with surfactant flushing to remove potential PTW in the source areas. Preliminary air permeability testing will be used to determine optimum well spacing, vacuum, and extraction rate. Preliminary conceptual design of the multiphase extraction system includes the following:

¾ Multiphase extraction wells spaced assuming a 15 ft radius of influence. This estimate may be refined based on preliminary air permeability testing results, if performed, and C-400 Interim Remedial Action lessons learned.

¾ An extraction rate of approximately 10 standard $ft^3$ per minute per extraction well, manifolded to one blower per site. This estimate may be refined based on preliminary air permeability testing results, if performed.

¾ 4-inch schedule 40 polyvinyl chloride well casings would be screened throughout the zone of contamination in the UCRS. Thirty ft of screen per well was assumed for conceptual design; however, this value may be revised based on preliminary air permeability testing results. Larger diameter well casings could be used, if determined during the RD to improve performance.

¾ A liquid ring pump would be utilized for high-vacuum extraction of materials.

The multiphase extraction system initially would be operated continuously. Soil gas concentrations in dedicated drive points and off-gas concentrations in individual wells would be monitored to optimize operations. Air flow from individual wells could be increased, reduced, or shut off depending on monitoring results. Additional performance enhancements, including passive recharge wells, could be implemented depending on results. Off-gas treatment would be required to meet air emission ARARs. Equilibrium partitioning of DNAPL TCE and soil air was assumed for conceptual design purposes.

Electrical supply and natural gas requirements for off-gas treatment also are provided. Natural gas would be used to heat the extracted vapor prior to passing through the carbon vessels. The preliminary conceptual design of the multiphase extraction off-gas treatment system for each site includes the following:

- Knock out tank. A knock out tank would be utilized to perform a crude disengagement of the gas and liquid extracted during the multiphase extraction process.

- Vapor phase carbon. Following the knock out tank, vapor would be passed through activated carbon vessels to adsorb contamination present in the vapor phase before being discharged through an exhaust.

Coproduced groundwater would be treated to meet liquid effluent ARARs and discharged. Recovery rates would be expected to decrease over time as the formation drained.

The preliminary conceptual design for coproduced groundwater treatment includes the following:

- Knock out tank. A knock out tank would be utilized to perform a crude disengagement of the gas and liquid extracted during the multiphase extraction process.

- Surfactant make-up tank. A surfactant make-up tank initially would be used to store unused surfactant. As reinjection events occur, the tank would be used to store the treated groundwater-surfactant mixture.

- Filtration. Contaminated groundwater would be passed through bag filters and a sand filtration unit to eliminate solids.

- Air stripper. Following the bag filters and sand filter unit, the extracted groundwater/surfactant mixture would be passed through an air stripper to remove volatile organic contamination present in the groundwater prior either to being reinjected into the UCRS or discharged.

Process monitoring would include soil moisture content, water levels, and soil gas VOC concentrations in the UCRS. Piezometers and neutron probe access tubes would be installed in the UCRS to the top of the RGA. Water levels and soil moisture contents would be monitored at least quarterly for the first year.

Sampling of multiphase extraction off-gas and dedicated soil gas points would be required for process optimization (e.g., to determine when to shut off individual extraction wells, when to switch to pulsed pumping, when to turn off the system, etc.). An operational sampling and monitoring plan would be prepared in the RD/RAWP. The preliminary conceptual design for soil vapor sampling and soil vapor monitoring includes the following:

- Weekly soil vapor off-gas sampling and analysis for VOCs; and
- Monthly soil gas dedicated drive point sampling and analysis for VOCs.

*In situ* surfactant-enhanced soil flushing would be used to supplement and increase the treatment efficiency of the multiphase extraction process. Surfactant-enhanced soil flushing is a source zone remediation technology typically used to remove the undissolved, residual-phase contamination (i.e., potential DNAPLs) from which the dissolved-phase plume is derived. A surfactant or "surface active" agent is a wetting agent capable of reducing the surface tension of a liquid or the interfacial tension between two liquids (i.e., DNAPL and water), thereby increasing the surface area for solubilization. Surfactant-enhanced soil flushing would facilitate contaminant removal by two primary mechanisms: first, through enhancing the mobility of the contaminant by reducing interfacial tension; and second, by increasing contaminant solubility. Contaminant mobility, increased by interfacial tension reduction, would allow the DNAPL to flow more readily through the subsurface and be removed by the high vacuum extraction methods implemented during multiphase extraction. Contaminant solubility also would increase by the formation of microemulsions. Aerobic biodegradation also may be enhanced during the soil flushing process, as surfactants are considered a co-metabolite to aerobic hydrocarbon digesting microbes. Following surfactant injection, the vacuum-enhanced multiphase extraction process would be utilized to extract the mobilized contaminant, surfactant, and the microemulsions formed during this process. The extracted surfactant and groundwater would be passed through the coproduced groundwater treatment system. The treated groundwater and surfactant then would be reinjected, as necessary, to utilize the surfactant through multiple injection events. Multiphase extraction wells would be designed to operate in either extraction or injection mode to limit the distances that must be travelled for system capture.

Operation and Maintenance (O&M) for Alternative 7 would consist of the following:

- Inspecting and maintaining multiphase extraction blowers;
- Inspecting and maintaining bag filtration and sand filtration units;
- Replacing carbon;
- Removing and disposing of filter solids; and
- Monitoring air and water discharge.

Confirmatory sampling in the treatment area would be implemented to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during RAWP development.

Secondary wastes would include coproduced groundwater, spent carbon, drill cuttings (produced during multiphase well installation), PPE, and decontamination fluids. Coproduced groundwater would be treated and discharged, as described previously. Spent GAC would be shipped off-site for regeneration. For cost-estimating purposes, drill cuttings, PPE, and decontamination fluids were assumed to require containerization, dewatering, and testing prior to off-site disposal. Actual dispositioning requirements would be determined by sampling of containerized soils. All secondary wastes would be managed in accordance with all ARARs.

Site restoration activities prior to remedy completion would include demobilizing and removing all RDSI equipment, sealing all MIP and soil coring locations with bentonite, reseeding disturbed vegetated areas at the C-720 Northeast Site, and repairing penetrations of asphalt and concrete at the C-720 Northeast and Southeast Sites.

Alternative 7 is applicable only to the C-720 Building Northeast (SWMU 211-A) and Southeast (SWMU 211-B) source areas. The total escalated project cost and present worth cost for Alternative 7 are $10.5M and $7.6M, respectively. The estimated time to attain RGs is 39 years.

**Alternative 8: *In Situ* Source Treatment Using EISB with Interim LUCs.** Alternative 8 would be initiated with an RDSI that would be performed to better determine the extent and distribution of VOCs, including potential DNAPL TCE, and to determine UCRS soil and groundwater parameters specific to the EISB technology. Based on the calculated RGs for VOC concentrations in source area soil, supplemental investigations to delineate the lateral and vertical extent of VOC contamination at the source areas would be completed as described for Alternative 3. The RDSI would be based on a systematically planned approach.

The conceptual design for the RDSI at the Oil Landfarm includes the following:

- Preliminary soil gas sampling using the MIP and on-site analysis for VOCs to estimate the areal and vertical extent of contamination including potential DNAPL;

- Soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent at locations that have been identified using the MIP results. Soil cores also would be evaluated to determine the presence or absence of DNAPL;

- Sampling of existing UCRS wells in the vicinity of the source areas and analysis for EISB parameters including VOCs, pH, oxidation reduction potential (ORP), dissolved oxygen, total and dissolved iron, total and dissolved manganese, sulfate, nitrate, methane, ethene, ethane, alkalinity, total organic carbon, and microbiological parameters; and

- Civil survey of all sampling and well locations.

Alternative 8 initially was considered only for application to the Oil Landfarm area. As such, Alternative 8 was not evaluated for the source zones at SWMUs 211-A and 211-B in the Revised FFS due to the presence of infrastructure near the C-720 Building. Subsequent to the final evaluation in the Revised FFS, however, DOE has determined that EISB will be applicable to SWMUs 211-A and 211-B using pressure injection methods as opposed to gravity injection and infiltration, which was evaluated in the Revised FFS.

The EISB will utilize a gravity feed EISB system to introduce the bioamendment into the subsurface at SWMU 1. The system would utilize two gravity injection techniques designed to horizontally and vertically distribute the bioamendment into the UCRS. These techniques would consist of the following elements:

- Horizontal infiltration gallery. This injection technique would consist of a trench approximately 4-ft deep backfilled with gravel, coupled with horizontal wells installed within the trench in a "herringbone" design (Figure 3.18 of the Revised FFS). The excavated material would be characterized, managed, and disposed of appropriately in accordance with ARARs. A berm surrounding the trench would be constructed. The horizontal infiltration gallery would increase effectiveness in the unsaturated vadose zone by raising the saturation levels while allowing the bioamendment mixture to infiltrate downward by gravity. The trench would be installed to cover the areal extent of the source area. At the Oil Landfarm, the horizontal infiltration gallery thereby essentially would be installed at the original location of VOC contamination release into the subsurface. This location may be visibly located at the Oil Landfarm by the depression that has formed on the surface. At the Oil Landfarm source area, the bioamendments added to the trench would percolate into the subsurface and would be expected to follow the original migration pathways of the TCE. The horizontal wells would be used to feed bioamendment into the gravel trench, thereby horizontally distributing the amendment within the boundaries of the source area. Following saturation of the trench with bioamendment, the mixture would be allowed to percolate into the subsurface of the UCRS. Periodic reinjection of bioamendment would occur, as needed. The schedule and requirements associated with reinjection events would be determined during the RD.

- Vertical gravity feed wells. Shallow and deep vertical wells would installed at approximately 20–30 ft deep and 40–50 ft deep, respectively, and would be installed to distribute the bioamendment into contaminated areas at mid- and low-depths of the UCRS. The bioamendment would be allowed to gravity feed from these wells into the subsurface. Bioamendment would be fed through the wells on a periodic basis (to be determined during the RD). If it is determined during implementation of remedial action that recirculation of the bioamendment is essential, these wells could be used as injection/extraction wells. Because of the anticipated low permeability of most of the matrix materials, it is believed that a sequential injection/extraction would be more effective than recirculation.

In application of EISB at the SWMUs 211-A and 211-B, the gravity feed gallery and wells will be replaced with wells that are capable of being utilized to inject the bioamendment. The injection wells are needed at the 211 SWMUs because of infrastructure interferences at the C-720 Building.

A bioamendment mixture (i.e., microbes, nutrients, and reductants) would be introduced into the subsurface via the horizontal infiltration gallery coupled with vertical gravity-feed wells. The bioamendment would be reintroduced on a periodic basis (to be determined during the RD and adjusted based upon ongoing monitoring of the performance of the bioremediation system). The specific bioamendment mixture would be determined using sample results from the RDSI. Due to characteristics that are similar to DNAPL, a lactate reductant potentially could be utilized to more efficiently imitate the DNAPL and follow similar migration pathways.

Confirmatory sampling in the treatment area would be required to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during RAWP development. The conceptual design for confirmatory sampling includes soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent. Depths and locations of cores would be determined based on the results of the RDSI.

Secondary wastes produced under this alternative would include drill cuttings, PPE, and decontamination fluids from the RDSI and purge water from groundwater monitoring. For cost-estimating purposes, drill cuttings, PPE, and decontamination fluids were assumed to require containerization, dewatering, and testing prior to off-site disposal. PCBs potentially present at the Oil Landfarm would be expected to occur at concentrations below 50 ppm and would not require management as Toxic Substances Control Act waste. Groundwater monitoring purge water either would be used as makeup water or containerized and treated on-site prior to discharge. Actual disposal requirements would be determined by sampling of containerized soils, decontamination fluids, and purge water. All secondary wastes would be managed in accordance with all ARARs.

Site restoration activities would include demobilizing and removing all equipment; backfilling the horizontal infiltration trenches, if desired; sealing all MIP, soil coring, and electron donor injection locations with bentonite; and reseeding disturbed vegetated areas at the Oil Landfarm. Monitoring wells would be left in place until soil RGs were attained.

### 2.9.2 Common Alternative Components

The following subsections provides descriptions of the common components that are included in all of the alternatives except Alternative 1¾ No Further Action.

#### 2.9.2.1 Interim LUCs

Interim LUCs are an integral part of Alternatives 2 through 8. LUCs include administrative restrictions on activities allowed on a property. There are a number of existing DOE Plant controls that are not LUCS for this action that are being maintained outside of the requirements of CERCLA due to the nature and security needs of the facility, but nonetheless serve to protect against unacceptable/uncontrolled exposures. Interim LUCs also would be implemented as part of the selected remedy.

#### 2.9.2.2 Existing controls

PGDP is a federal facility with restricted access to the general public. Physical access to PGDP is prohibited and controlled by security fencing and armed guards that patrol the DOE property 24 hours per day to restrict worker entry and prevent uncontrolled access by the public/site visitors. These existing DOE controls are not LUCs for this action and are being maintained outside of the requirements of CERCLA due to the nature and security needs of the facility. These existing DOE controls are effective at preventing public access and unwanted trespassers to contaminated areas of the facility. Current DOE plant controls associated with the C-747-C Oil Landfarm and the C-720 Northeast and Southeast Sites consist of the following:

- The sites are within areas protected from trespassing under the 1954 Atomic Energy Act as amended (referred to as the 229 Line). These areas are posted as “no trespassing” and trespassers are subject to arrest and prosecution. Physical access to PGDP is prohibited by security fencing, and armed guards patrol the DOE property 24 hours per day to restrict workers entry and prevent uncontrolled access by the public/site visitors. These existing DOE controls are maintained outside of the requirements of CERCLA due to the nature and security needs of the facility (DOE 2008).

- Vehicle access to the sites is restricted by passage through Security Posts and by the plant vehicle protection barrier.

- The sites are in areas that are subject to routine patrol and visual inspection by plant protective forces, at a minimum once per shift.

- Protection of the current PGDP industrial workers is addressed under DOE’s Integrated Safety Management System/Environmental Management System program and 29 *CFR* § 1910. Additional work area controls that may be used under these programs during implementation of a remedy include warning and informational postings, temporary fencing and/or barricades, and visitor sign-in controls. These existing controls are implemented through for protection of worker safety and health and are outside the requirements of CERCLA.

- Section XLII of the FFA requires the sale or transfer of the site to comply with Section 120(h) of CERCLA. In the event DOE determines to enter into any contract for the sale or transfer of any of PGDP, DOE will comply with the applicable requirements of Section 120(h) in effectuating that sale or transfer, including all notice requirements. In addition, DOE will notify EPA and Kentucky of any such sale or transfer at least 90 days prior to such sale or transfer.

#### 2.9.2.3 Interim LUCs

As part of Alternatives 2 through 8, interim LUCs would be implemented through the existing E/PP program and posting of warning signs at the source areas to achieve RAOs 2a and 2b. The E/PP program is an interim control administered by DOE's contractors at PGDP designed to provide a common sitewide system to identify and control potential personnel hazards related to trenching, excavation, and penetration. The primary objective of the E/PP program is to provide notice to the organization requesting a permit of existing underground utility lines, contamination areas, and/or other structures and to ensure that any E/PP activity is conducted safely and in accordance with all environmental compliance requirements pertinent to the area (DOE 2008). Warning signs will be placed at each of the source areas to provide information to alert the public and industrial workers of the presence of the contamination in the area. The sign placement/location, sizing, and verbiage details will be contained in the RAWP. The existing E/PP program and warning signs are LUCs that will be implemented on an interim basis pending remedy selection as part of the Soils or Groundwater OUs.

#### 2.9.2.4 Groundwater monitoring

Monitoring for the C-747-C Oil Landfarm and the C-720 Northeast and Southeast Sites will be performed in support of implementation of the selected remedial action. Baseline groundwater monitoring will provide information about the extent and magnitude of VOC contamination prior to remedial action. Subsequent operational and postoperational monitoring will be used to help determine remedy effectiveness and attainment of RAOs over time.

### 2.9.3 Five-Year Reviews

Because the selected remedial action will result in hazardous substances remaining on-site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review under CERCLA Section 121(c) will be conducted every five years until the levels of COCs allow for unlimited use and unrestricted exposures of the soil and groundwater. The five-year reviews will be conducted to ensure that the remedy is or will be protective of human health and the environment. If the results of the five-year reviews reveal that remedy integrity is compromised and protection of human health and the environment is insufficient, the potential benefits of implementing additional remedial actions then will be evaluated by the FFA parties. The statutory reviews will be conducted in accordance with CERCLA 121(c), the NCP at 40 *CFR* § 300.430(f)(5)(iii)(C), and EPA guidance. These reviews although required by CERCLA are not considered components of the selected remedies.

## 2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires that the CERCLA remedy selection be based on evaluation of nine selection criteria. Those criteria are placed in three categories. The first two are Threshold Criteria that each potential alternative must meet for selection. The next five criteria, 3 through 7, are considered Balancing Criteria. The last two criteria, 8 and 9, are considered Modifying Criteria and are considered once the proposed alternative has undergone public review. The following paragraphs provide a brief description of the detailed analysis within each criterion.

(1) **Overall protection of human health and the environment.** This threshold criterion requires that the remedial alternative selected adequately protect human health and the environment, in both the short and long term. Protection must be demonstrated by the elimination, reduction, or control of unacceptable risks.

(2) **Compliance with ARARs.** This threshold criterion requires that the alternatives be assessed to determine if they attain compliance with ARARs or satisfy the requirements for waiver of ARARs.

(3) **Long-term effectiveness and permanence.** This primary balancing criterion focuses on the magnitude and nature of the risks associated with untreated waste and/or treatment residuals remaining at the conclusion of remedial activities. This criterion includes consideration of the adequacy and reliability of any associated containment systems and institutional controls, such as monitoring and maintenance requirements, necessary to manage treatment residuals and untreated waste.

(4) **Reduction of contaminant toxicity, mobility, or volume through treatment.** This primary balancing criterion is used to evaluate the degree to which the alternative employs recycling or treatment to reduce the toxicity, mobility, or volume of the contamination.

(5) **Short-term effectiveness.** This primary balancing criterion is used to evaluate the effect of implementing the alternative relative to the potential risks to the general public, potential threat to workers, potential environmental impacts, and the time required until protection is achieved.

(6) **Implementability.** This primary balancing criterion is used to evaluate potential difficulties associated with implementing the alternative. This may include technical feasibility, administrative feasibility, and the availability of services and materials.

(7) **Cost.** This primary balancing criterion is used to evaluate the estimated costs of the alternatives. Expenditures include the capital cost and O&M.

(8) **State acceptance.** This modifying criterion provides for consideration of any formal comments from the state on the PP.

(9) **Community acceptance.** This modifying criterion provides for consideration of any formal comments from the community on the PP.

### 2.10.1 Overall Protection of Human Health and the Environment

This threshold criterion evaluates the ability of an alternative to provide adequate protection of human health and the environment. The overall evaluation primarily draws from assessments of long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

For Alternatives 2 through 8, the use of monitoring and interim LUCs, would assure that risks to workers and off-site residents were controlled until final remedy selection as part of subsequent OUs that would address the relevant media. The Southwest Plume sites are located more than one mile from any current residential population, and effects on outlying communities would be negligible because the PGDP Water Policy (not part of this action) continues to provide water to residents, access restrictions, and groundwater use restrictions in the PGDP area, which eliminate groundwater exposure risks.

Alternatives 3 through 8 also would meet this threshold criterion through treatment of VOCs in soil including removing potential PTW. The E/PP program and warning signs contained in the interim LUCs would protect workers and the public. The mass of non-VOCs would not be reduced to the RGs by Alternatives 1, 2, 3, 5, 6, or 8; however, interim LUCs (warning signs and E/PP program) would limit exposures pending remedy selection as part of subsequent OUs that addresses relevant media. Non-VOCs would be removed in the excavated material removed during implementation of Alternative 4, and potential extraction and removal of metals during filtration potentially could occur as a result of Alternative 7.

Alternative 1 would not meet the threshold criterion of overall protection of human health and the environment. Alternative 1 would provide no interim protection during the over 100 years that would be required to attain MCLs and groundwater protection RGs at the C-720 Northeast and Southeast Sites and at the Oil Landfarm, based on modeling results for a TCE half-life of 25 years.

### 2.10.2 Compliance with ARARs

Alternatives 2 through 8 meet this threshold criterion. Alternatives 2 through 8 also would meet location- and action-specific ARARs through design and planning during preparation of the RD/RAWP. Although no chemical-specific ARARs were identified, the MCL for TCE and the associated breakdown products was used to develop groundwater protection RGs for site soils. Although Alternative 1 would be compliant with ARARs, it would not meet both threshold criteria.

### 2.10.3 Long-Term Effectiveness and Permanence

The overall ranking, highest to lowest, of the alternatives with respect to long-term effectiveness and permanence is as follows:

SWMU 1, Oil Landfarm—4, 5, 3, 8, 2, and 1.

SWMUs 211-A and 211-B, C-720 Northeast & Southeast—5, 7, 6, 8, 2, and 1.

**Oil Landfarm**—Long-term effectiveness and permanence has been evaluated for alternatives developed for potential implementation at the Oil Landfarm. Alternative 4 or 5 would provide the best long-term effectiveness and permanence for the Oil Landfarm, because groundwater protection RGs could be attained and RAOs met in approximately 38 or 39 years, respectively. Alternative 3 would rank behind Alternatives 4 and 5, with an expected duration of 68 years until groundwater protection RGs could be attained. Alternatives 8 and 2 would provide the least long-term effectiveness and permanence, apart from no action, for the Oil Landfarm due to the length of time until groundwater protection RGs potentially would be met (93 years and greater than 100 years, respectively). Non-VOC concentrations would be reduced by excavation in Alternative 4, but not by excavation for any other alternatives developed for the Oil Landfarm; however, the E/PP program will limit exposures pending remedy selection as part of subsequent OUs that addresses relevant media.

**C-720 Northeast and Southeast**—Long-term effectiveness and permanence has been evaluated for alternatives developed for potential implementation at the C-720 Northeast and Southeast Sites. Alternative 5 would provide the best long-term effectiveness and permanence for the C-720 Northeast or Southeast Sites because groundwater protection RGs could be attained and RAOs met in approximately 20 years. Alternative 7 would rank behind Alternative 5 with an expected duration of 39 years until groundwater protection RGs could be attained. Alternative 6 would provide some long-term effectiveness and permanence, but is not as effective as Alternatives 5 or 7. The estimated time until groundwater protection RGs would be met following implementation of Alternative 6 is approximately 52 years. As at the Oil Landfarm, Alternatives 8 and 2 would provide the least long-term effectiveness and permanence, apart from no action, for the C-720 Northeast and Southeast Sites due to the length of time until groundwater protection RGs potentially would be met (83 years and 97 years, respectively). Non-VOC concentrations would not be reduced by Alternatives 2, 5, or 6; however, the E/PP program will limit exposures pending remedy selection as part of subsequent OUs that address relevant media. Potential extraction and removal of metals during filtration potentially could occur as a result of Alternative 7.

Alternative 1 would provide limited long-term effectiveness or permanence. Alternative 1 provides no measures to control risks to workers, off-site residents, or the environment, pending attainment of RGs, which is projected to require over 100 years.

### 2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternatives employ treatment or recycling that reduces toxicity, mobility, or volume was assessed. The overall ranking of alternatives with respect to reduction of toxicity, mobility, and volume through treatment, highest to lowest, is as follows:

SWMU 1, Oil Landfarm—4, 5, 3, 8, 2, and 1.

SWMUs 211-A and 211-B, C-720 Northeast & Southeast—5, 7, 6, 8, 2, and 1.

**Oil Landfarm**—Alternative 4 would accomplish the greatest reduction of toxicity, mobility, and volume at the Oil Landfarm using LDA excavation and *in situ* treatment of the "buffer zone." The excavation process would be designed to remove 100% of the contamination present above the "buffer zone" as possible. Alternative 5 through the electrical resistive heating also would result in a significant reduction in toxicity, mobility, and volume, with an estimated treatment efficiency of 98%. Alternative 3 would accomplish less reduction of VOC mass than Alternatives 4 or 5, with an estimated treatment efficiency of 91%; however, the reduction in VOC mobility would be significant. Alternative 3 will reduce the toxicity through the use of a destruction process such as oxidation. The estimated treatment efficiency of Alternative 8 is 60% at the Oil Landfarm. Although the biological action associated with Alternative 8 will result in continued declining toxicity and volume, the process is slower than say the excavation associated with Alternative 4. Neither Alternative 1 nor Alternative 2 would implement active treatment, and reductions in concentrations would occur only through natural processes.

**C-720 Northeast and Southeast**—At the C-720 Northeast and Southeast Sites, Alternative 5 would accomplish the greatest reduction of toxicity, mobility, and volume using the *in situ* ERH process. A treatment efficiency of 98% was estimated for Alternative 5 at the C-720 Northeast and Southeast Sites. Alternative 7 also would result in a significant reduction in toxicity, mobility, and volume, with an estimated treatment efficiency of 95%. Both of these alternatives would extract the contaminant from the subsurface, reducing its mobility and volume in the subsurface. The contaminant would be managed at the surface that may further treat the contaminant reducing its toxicity. Alternative 6 would accomplish less reduction of VOC mass than Alternatives 5 or 7, with an estimated treatment efficiency of 90%, but its treatment would be by *in situ* treatment that would lead to destruction. Neither Alternative 1 nor Alternative 2 would implement active treatment, and reductions in concentrations would occur only through natural processes.

### 2.10.5 Short-Term Effectiveness

The overall ranking of Oil Landfarm and C-720 Northeast and Southeast alternatives with respect to short-term effectiveness, highest to lowest, is as follows:

SWMU 1, Oil Landfarm—3, 5, 4, 8, 2, and 1.

C-720 Northeast and Southeast—5, 7, 6, 8, 2, and 1.

**Oil Landfarm**—Alternative 3 would provide the highest short-term effectiveness for the Oil Landfarm. Although the potential for worker exposure during the soil mixing process exists, the *in situ* nature of the treatment, coupled with a relatively short duration until groundwater protection RGs would be met, provides high short-term efficiency. In addition, the soil mixing process is estimated to take approximately four months of active remediation, less than that required for Alternatives 4, 5, or 8. Alternative 5 would rank behind Alternative 3. Although the time until VOC RGs would be attained is less than Alternative 3, the worker exposure risks are greater. Worker exposure risks would exist while drilling and installing electrode/vapor recovery wells in contaminated soil areas and also would result in thermal and electrical hazards. The associated increase in requirements for safety analysis, hazard identification, and control would result in increased complexity and cost for implementation; however, all of these issues were successfully resolved for the C-400 ERH Treatability Study. The short-term efficiency of Alternative 4 ranks behind Alternatives 3 and 5. The *ex situ* waste management, characterization, handling, and disposal included in Alternative 4 pose significant health and safety challenges associated with the potential for worker exposure to contaminated media. Alternative 4 short-term effectiveness is reduced due to creation of large-diameter, very deep (60 ft) excavations that must be controlled. Although minimal potential exists for worker exposures to contaminated media during implementation of Alternatives 8 and 2, these alternatives provide the least short-term efficiency due to the significant amount of time required to attain groundwater protection RGs (93 years and greater than 100 years, respectively).

**C-720 Northeast and Southeast**—At the C-720 Northeast and Southeast Sites, Alternatives 5 and 7 would provide the highest short-term effectiveness. Although the potential exists for worker exposure during the ERH and multiphase extraction processes, the relatively short durations until groundwater protection RGs would be met provide high short-term efficiency (20 years and 39 years, respectively). Worker exposure risks associated with implementation of Alternative 5 would include those described in the previous paragraph for the Oil Landfarm for these process options. Alternative 7 would result in worker chemical exposure risks during multiphase and groundwater monitoring well installation, requiring on-site industrial hygienist coverage during drilling, in addition to appropriate monitoring, PPE, and procedures. Surfactant flushing associated with Alternative 7 would result in the contaminants being brought to the surface to be handled. Alternative 6 ranks behind Alternatives 5 and 7 due to the length of time required for VOC concentrations to meet groundwater protection RGs (approximately 52 years). The LAI process most likely would pose fewer health and safety exposure risks than Alternatives 5 or 7 due to the minimal amount of time required for active remediation (approximately 1 month). Alternative 8 has a lower ranking than Alternative 6 since it has a longer remediation time frame (83 years) as opposed to 52 years for Alternative 6, for which the worker and public must be protected. Alternative 8 poses only low hazard activities associated with injecting nutrients, which are fairly inert substances and pose minimal health and safety risk to workers. Although minimal potential exists for worker exposures to contaminated media during implementation of Alternative 2, this alternative provides the least short-term efficiency due to the significant amount of time required to attain groundwater protection RGs (approximately 97 years).

Alternative 1 has the lowest short-term effectiveness because it requires the longest time (>100 years) for attainment of RGs.

### 2.10.6 Implementability

The overall ranking of the eight alternatives with respect to implementability, highest to lowest, is as follows:

SWMU 1, Oil Landfarm—1, 2, 8, 3, 5, and 4.

C-720 Northeast and Southeast—1, 2, 8, 6, 7, and 5.

**Oil Landfarm**—Alternative 1 would be the most readily implementable alternative, because no action would be taken. Alternative 2 ranks high in implementability as well because no active treatment is included; a groundwater monitoring system will be required for long-term monitoring to examine contaminant trends after remedy implementation and assess progress toward achieving cleanup objectives. The amount of drilling will decrease the implementability as compared to Alternative 1.

Alternative 8 ranks the next highest following Alternative 2. Alternative 8 requires installation of a trench and injection wells within the boundaries of the source area; however, Alternative 8 uses readily available industry equipment and services and is less intrusive or worker intensive than Alternatives 3, 4, or 5. Alternative 3 ranks behind Alternatives 1, 2, or 8, but ranks higher in implementability than Alternatives 4 or 5. The amount of *ex situ* waste management required during Alternative 3 is significantly less than Alternatives 4 or 5, and the amount of time required to implement deep soil mixing is less than Alternative 4. Implementability of Alternative 4 is relatively low due to the worker protection issues discussed previously under short-term effectiveness. Implementability constraints for Alternative 5 would include the technical complexity of the alternative, relatively few vendors offering the technology, and the worker protection issues discussed previously under short-term effectiveness; however, these constraints were resolved for the C-400 ERH Treatability Study. No O&M would be required after completion of the ERH treatment; however, long-term groundwater monitoring and five-year reviews would be required as long as VOC concentrations in soil remained above RGs.

**C-720 Northeast and Southeast**—For the C-720 Northeast and Southeast Sites, Alternatives 1 and 2 have the highest implementability since no active remedial actions would be implemented. Although alternative 2 is expected to have a monitoring system, which reduces its implementability as compared to Alternative 1. Alternative 8 ranks closely behind Alternative 2. Both alternatives will result in well installation only for the C-720 sites; however, some of the Alternative 8 wells will be used for injection of bioamendment and will require tanks and injection pumps. Alternative 6 follows Alternative 8 because it requires geometric spacing of wells as in Alternatives 5 and 7, which makes implementation more difficult due to infrastructure presence. The ability to implement Alternative 6 within a highly industrialized area is greater than with Alternatives 5 or 7 because no permanent wells would be required to be installed within the boundaries of the source areas, and the duration of active treatment (approximately 1 month) is less than the time required for Alternatives 5 or 7. An implementability constraint associated with the LAI process is that relatively few vendors offer this technology (or equivalent). Implementability constraints for Alternative 5 are the same as those described above for the Oil Landfarm. Alternative 7 could be implemented using readily available industry equipment and services; however, the longer period of O&M relative to Alternatives 6 or 5 reduces the overall implementability. Treatment of off-gas and coproduced groundwater and monitoring of soil vapor and soil moisture monitoring will require the presence of piping, tubing, electrical, and control cables to the various wells that will be inhibit implementability. Alternatives 5 and 7 both have longer estimated operating durations.

### 2.10.7 Cost

Under this balancing criterion, the cost of each alternative is evaluated. The estimates are intended to aid in making project evaluations and comparisons between alternatives. Consistent with EPA guidance (EPA 1988), the estimates have an expected accuracy of -30% to +50% for the scope of action described for each alternative. Table 13 presents the cost estimates that were developed for each alternative. The table presents the cost estimates in escalated form and present-value form. A discount factor of 2.3% was used in developing the present-value cost estimate.

The overall ranking of alternatives with respect to the estimated escalated cost, lowest to highest cost, is as follows:

SWMU 1, Oil Landfarm—1, 2, 8, 3, 4, 5.

C-720 Northeast and Southeast (Combined)—1, 8, 2, 7, 6, and 5.

**Table 13. Summary of Alternative Costs (Total Escalated Values)**

| Alternative* | C-720 Northeast Site ($M) | | C-720 Southeast Site ($M) | | Oil Landfarm ($M) | |
|---|---|---|---|---|---|---|
| **Escalated/Present Value** | Escalated | Present | Escalated | Present | Escalated | Present |
| **Alternative 1**—No further action | $0 | $0 | $0 | $0 | $0 | $0 |
| **Alternative 2**—Long-term monitoring | $3.2 | $1.9 | $3.2 | $1.9 | $2.9 | $1.8 |
| **Alternative 3**—*In situ* source treatment using deep soil mixing | n/a | n/a | n/a | n/a | $11.9 | $10.3 |
| **Alternative 4**—Source removal and *in situ* chemical source treatment | n/a | n/a | n/a | n/a | $28.3 | $25.8 |
| **Alternative 5**—*In situ* thermal source treatment | $15.6 | $13.7 | $9.2 | $7.6 | $19.8 | $17.8 |
| **Alternative 6**—*In situ* source treatment using LAI | $5.8 | $4.3 | $5.3 | $3.9 | n/a | n/a |
| **Alternative 7**—*In situ* soil flushing and source treatment using multiphase extraction | $5.4 | $3.9 | $5.1 | $3.7 | n/a | n/a |
| **Alternative 8**—*In situ* source treatment using EISB | $4.7 | $3.3 | $5.4 | $4.0 | $6.1 | $4.7 |

*Alternatives 2 through 8 include use of interim LUCs.
Capital and Operation and Maintenance cost estimates for the selected and preferred remedial actions are shown in Tables 17, 18, and 19.
n/a = not applicable

### 2.10.8 State Acceptance

The Revised FFS, PP, and ROD were issued for review and comment to both the KDEP and EPA. KDEP and EPA concur with the need for a remedial action for the source zones comprised of TCE and other VOCs in the UCRS at the C-747-C Oil Landfarm and C-720 Building SWMU 211-A and 211-B areas. These support agencies also concur with the selection of Alternative 3 for the Oil Landfarm and Alternative 8 for C-720 Northeast (211-A) and Southeast (211-B) Sites. It also is agreed that selection of Alternatives 3 and 8 is consistent with the requirements of the Commonwealth of Kentucky's Hazardous Waste Permit.

### 2.10.9 Community Acceptance

[Preliminary Text]No groups or organizations opposed the proposed remedy selection for the source zones comprised of TCE and other VOCs in the UCRS and RGA at the C-747-C Oil Landfarm and C-720 Building SWMU 211-A and 211-B areas. Community responses to the proposed plan alternatives are presented in the responsiveness summary, which addresses comments received during the public comment period that ran from TBD to TBD. A public meeting was not requested during the public comment period; therefore no public meeting was held.

## 2.11 SELECTED REMEDY

**C-720 Northeast and Southeast**—Based upon the evaluation of the alternatives in the Revised FFS with regard to the CERCLA nine criteria, two alternative remedial actions have been identified for C-720 Northeast and Southeast sites, Alternative 8—*In Situ* Source Treatment using EISB with Interim LUCs and Alternative 2—Long-term Monitoring with Interim LUCs. The process for selection of the remedy for the C-720 sites requires performance of a FC/RDSI to obtain updated information on the extent and magnitude of contamination in the subsurface. Based on the results of the FC/RDSI, the FFA parties will determine if active treatment is warranted for each of the C-720 sites, and Alternative 8 or Alternative 2 will be selected accordingly. The basis for selecting the remedial action for the C-720 sites will hinge on the results on the final characterization, a comparison of current and historical VOC contaminant levels, and an estimation of the time required to achieve remedial goals. The selected remedial action will be documented in a FFA Primary Document by the FFA parties.

**Oil Landfarm**—Based upon the evaluation of the alternatives with regard to the nine criteria, one alternative has been selected for the Oil Landfarm. The selected alternative is Alternative 3—*In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs.

### 2.11.1 Summary of Rationale for the Selected Remedies

The following rationale supports the selection of the alternatives:

**C-720 Northeast and Southeast**—The Selected Alternative will be initiated by performing a Final Characterization of both SWMUs to confirm source extent and magnitude at each SWMU. The results of the field data collection will be reviewed by the FFA parties and a determination will be made as to whether Alternative 8 or Alternative 2 will be implemented. This determination will be based on whether the level of contamination present in the subsurface soils warrants treatment or whether monitoring will be sufficient and this determination will be provided as a recommendation by DOE to KDEP and EPA. If contaminant concentration data from C-720 SWMUs 211-A and 211-B show that contaminants levels are of a nature and extent that will not require the moderately aggressive action contained in Alternative 8 and RGs may be met within a reasonable time frame using attenuation, Alternative 2 will be implemented.

<u>*Alternative 8*</u>—Alternative 8 applied to the C-720 Building SWMUs 211-A and 211-B sites meets the threshold criteria (overall protection of human health and the environment and compliance with ARARs). The monitoring and interim LUCs will provide notice and warning of environmental contamination for any residual or remaining VOC and non-VOC that is not treated by this RA. EISB will address the presence of the VOC contamination including vapor, dissolved, sorbed, and potential DNAPL through the addition of bioamendments to the UCRS. RAO 1 would be met by removing source material via *in situ* destruction by bacteria. RAO 2a would be met by removing VOCs to levels within EPA's generally acceptable cancer risk range for site-related exposures of E-04 to E-06 and reducing the VOCs lowers the noncancer HI for VOCs to less than 1. The attainment of RAO 2a also is supported by interim LUCs. RAO 2b would be met by implementing interim LUCs. RAO 3 would be met by reducing VOC soil concentrations to groundwater protection RGs either through treatment by biological remediation of the source material or attenuation. Alternative 8 would provide for good long-term effectiveness and permanence because it removes a significant amount of TCE source from affected media. The EISB is expected initially to remove approximately 60% of the contaminant mass, which is less that some of the other more aggressive remedies such as ERH and multiphase extraction. Subsequent to active treatment, the remaining mass, is expected to attenuate within approximately estimated 83 years. *In situ* treatment will result in a reduction of volume consistent with the CERCLA preference for Reduction of Toxicity, Mobility, or Volume through Treatment. Alternative 8 at SWMUs 211-A and 211-B is anticipated to be

moderately effective over the short-term when compared to other more aggressive remedies. EISB is not expected to result in the potential for worker contamination since the alternative uses bioamendments and low pressure injection for the SWMUs. The time to attain RGs is expected to be approximately 83 years. The estimated time range necessary to reach the UCRS soil RG for TCE is dependent on the TCE attenuation rate in the UCRS (TCE half-life in UCRS years) and is shown in the Table 14. The range of time in years (half-life) utilized to assess TCE attenuation is intended to bracket the expected rate of natural reduction in TCE concentrations in the UCRS due to natural attenuation.

**Table 14. Alternative 8 TCE Attenuation Rate in the UCRS**

| TCE Half-Life in UCRS, Years | Time to Reach MCL in RGA after Alternative 8 Treatment Years |
|---|---|
| | SWMUs 211-A & 211-B |
| 5 | 28 |
| 25 | 83 |
| 50 | > 100 |

The moderate short-term effectiveness of Alternative 8 (i.e., time to meet RAOs) is addressed through interim LUCs. The risks to workers can be managed throughout the extended implementation period. Alternative 8 has moderate to high implementability due to its demonstrated technology, standard construction techniques, and multiple vendors. The cost of Alternative 8 in escalated dollars at the two C-720 SWMUs is ($4.8M), which is the lowest for the alternatives containing treatment.

Criteria for discontinuing enhanced *in situ* bioremediation will be developed. Two parameters available for determining completion are groundwater concentrations and confirmation soil sampling. Specific parameters and values will be defined for completion criteria by the FFA parties in subsequent CERCLA documents (e.g., RAWP).

*Alternative 2*—Alternative 2, applied to the C-720 Building SWMUs 211-A and 211-B sites, meets the threshold criteria (Overall Protection of Human Health and the Environment and Compliance with ARARs). The monitoring and interim LUCs will provide notice and warning of environmental contamination for any remaining VOC and non-VOC that is present until attenuation, including dispersion and dilution reduces the concentrations to meet the remediation goals. Long-term monitoring is considered to be acceptable for the 211 SWMUs because it will have been determined by the FFA parties that implementation of an active remedy is not required to meet the remedial objectives within a reasonable time frame. If VOCs are observed to be reduced due to natural processes from the concentrations in the historical data set, RAO 1 would be met by virtue of not being applicable since the magnitude and extent of contamination would not warrant treatment.. RAO 2a would be met by reducing VOCs via natural processes to levels within EPA's generally acceptable cancer risk range for site-related exposures of E-04 to E-06. The reduction in the VOCs also lowers the noncancer HI for VOCs to less than 1. The attainment of RAO 2a also is supported by interim LUCs. RAO 2b would be met by implementing interim LUCs. RAO 3 would be met by reducing VOC soil concentrations to groundwater protection RGs through attenuation of the source material. Alternative 3's long-term effectiveness, as currently evaluated, is the lowest of all alternatives except Alternative 1—No Action. If, however, it is determined, as discussed above, that the magnitude and extent of contamination at each of the C-720 sites does not warrant active treatment, then the expected time frame for meeting the RGs is projected to be 97 years. This approach would provide for acceptable long-term effectiveness and permanence. The currently estimated time frame for attaining RGs with Alternative 2 is shown in Table 15. The range of time in years (half-life) utilized to assess TCE attenuation is intended to bracket the expected rate of natural reduction in TCE concentrations in the UCRS due to natural attenuation. Since long-term monitoring does not include treatment, the only reduction of toxicity, mobility, or volume would be through attenuation such as dispersion and degradation.

**Table 15. Alternative 2 TCE Attenuation Rate in the UCRS**

| TCE Half-Life in UCRS, Years | Time to Reach MCL in RGA after Alternative 2 Treatment Years |
|---|---|
| | SWMUs 211-A & 211-B |
| 5 | 35 |
| 25 | 97 |
| 50 | > 100 |

Alternative 2 has only monitoring activities that could produce a risk to the worker. Those risks, however, are easily managed. Moderate short-term effectiveness (i.e., time to meet RAOs) is addressed through interim LUCs. The risks to workers can be managed throughout the extended implementation period. Alternative 2 has high implementability since it contains only active monitoring activities and LUCs that are easily implemented through standard environmental methods. The cost of Alternative 2 in escalated dollars at the two C-720 SWMUs is ($6.4M).

**Oil Landfarm**—Alternative 3 meets both threshold criteria. Overall protection of human health and the environment is met by the removal of 91% of the contaminant mass present in the landfarm source area. With that source reduction and the placement of interim LUCs until the remaining source can attenuate, an estimated 68 years, the public is protected. Since the contaminant is at depth and is not available to migrate to the surface at concentrations posing a risk to the environment, it is protected. All ARARs are met with the implementation of deep soil mixing. For long-term effectiveness and permanence, the removal rate ranks within 10% of the most effective Alternative 5. The effectiveness is further supported by the interim LUCs that will be in place until the RGs are met. The currently estimated time frame for attaining RGs with Alternative 3 is shown in Table 16. The range of time in years (half-life) utilized to assess TCE attenuation is intended to bracket the expected rate of natural reduction in TCE concentrations in the UCRS due to natural attenuation. Deep Soil Mixing will treat to remove or destruct an estimated 91%; therefore, it ranks moderate to high in the reduction of toxicity, mobility, or volume through treatment.

**Table 16. Alternative 3 TCE Attenuation Rate in the UCRS**

| TCE Half-Life in UCRS, Years | Time to Reach MCL in RGA after Alternative 3 Treatment Years |
|---|---|
| | Oil Landfarm—SWMU 1 |
| 5 | 25 |
| 25 | 68 |
| 50 | 87 |

Alternative 3 will produce some short-term risks since the soil mixing with large equipment and use of reactive reagents or potentially steam. Since the estimated 90% of source material will be removed by the mixing, which will be performed in an expected four months of operations, the largest portion of the risk will have been removed quickly. Those risk not reduced by the mixing treatment will be managed through the interim LUCs. The cost of Alternative 3 in escalated dollars at the Oil Landfarm is ($11.9M).

Based on the information currently available, DOE believes that Alternative 3 at the Oil Landfarm—SWMU 1, and either Alternative 8 or Alternative 2, applied after Final Characterization of the C-720 Northeast—SWMU 211-A and Southeast—SWMU 211-B Sites, meet the threshold criteria and provide the best balance of tradeoffs among the alternatives with respect to the balancing and modifying criteria for remedy selection. This preferred alternative is expected to (1) be protective of human health and the environment; (2) meet federal and state ARARs for the scope of this final action for VOCs; (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies to the maximum extent practicable; and (5) satisfy CERCLA's preference for treatment as a principal element of the remedy. The implementation of Alternative 3 and Alternative 2 or 8 is integral to attaining the long-term goal at PGDP of returning groundwater to its beneficial use because this combination of alternatives permanently removes a significant portion of the TCE contamination found in the source zones at the C-747-C Oil Landfarm.

### 2.11.2 Description of the Selected Remedy

#### C-720 Building—SWMUs 211-A and 211-B

A FC of the SWMUs will be performed as part of the remedial action for these two SWMUs. Following that characterization, the FFA parties will determine whether to implement either Alternative 8—*In Situ* Source Treatment using EISB with Interim LUCs (Figure 6) or Alternative 2—Long-term Monitoring with Interim LUCs (Figure 7). These two alternatives will consist of the following major components.

<u>*Alternative 8*</u>*:*

- **RDSI—**The investigation will be the same as performed for Alternative 8 and will, in part, be considered the FC used by the FFA parties to determine whether to implement Alternative 8 or 2. For efficiency, data that is necessary to support the design and implementation of the either Alternative 2 or Alternative 8 will be collected. For Alternative 8, the investigation will include collecting data to refine the source areas to be treated and to quantify soil, groundwater, and contaminant parameters to be utilized in the design of the bioremediation treatment. The RDSI also will include the Final Characterization effort that will be used to determine whether to implement Alternative 8 or Alternative 2.

- **Enhanced *In Situ* Bioremediation System**—A bioamendment composed of microbes, nutrients, and/or reductants, as necessary, will be injected or placed in the wells to allow the amendment to enter the subsurface either by gravity or under pressure. Periodically, additional bioamendment will be added to the system. The amendment will enhance subsurface biological activity, which will result in the destruction of the TCE contaminant by the microbes. Testing and monitoring will include measuring of bioamendment concentrations and groundwater parameters during the *in situ* operation.

- **Groundwater monitoring—**Groundwater sampling and testing will be performed prior to, during, and following the remediation to determine how groundwater contaminant levels are changing and if the treatment is having an impact on the RGA groundwater concentration.

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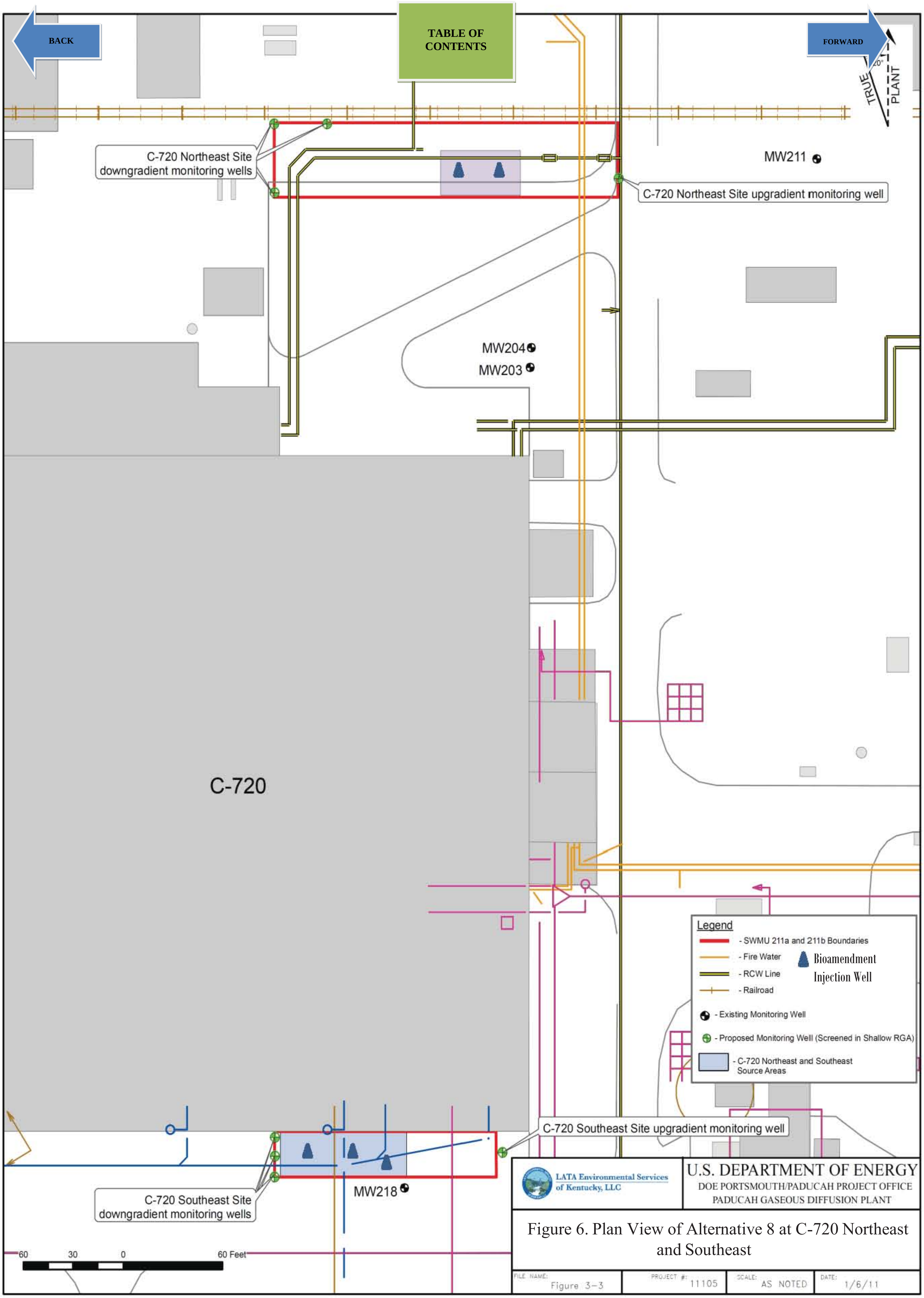


Figure 6. Plan View of Alternative 8 at C-720 Northeast and Southeast

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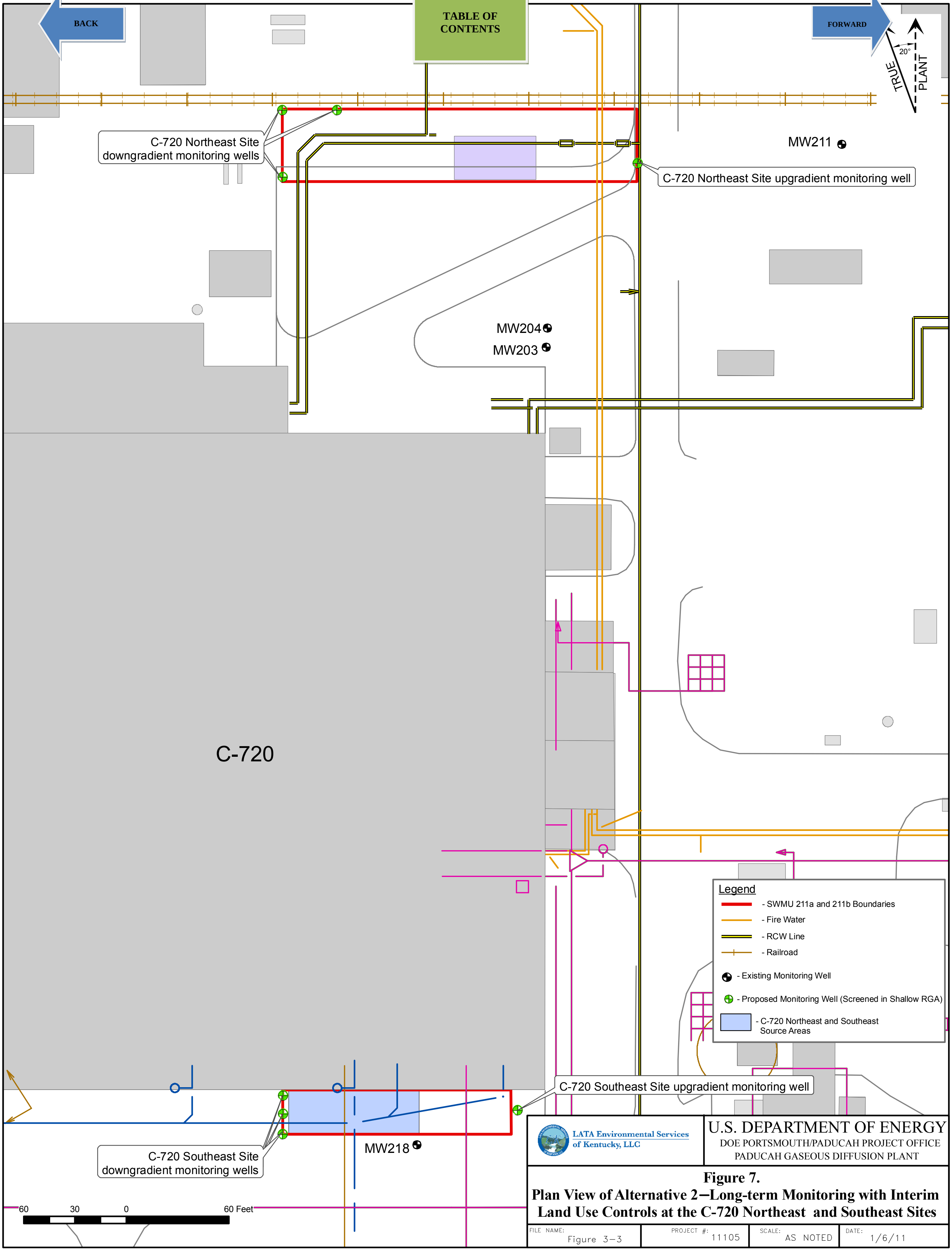


**Figure 7.**
**Plan View of Alternative 2—Long-term Monitoring with Interim Land Use Controls at the C-720 Northeast and Southeast Sites**

- **Confirmatory sampling for VOCs—**Results from soil sampling will be used to determine if the remedial actions have met the RGs.

- **Secondary waste management—**The remedial action will generate waste materials that will require disposition including contaminated water, drill cuttings, soils, bioamendment, and general construction debris. These materials will require management and disposal in accordance with ARARs.

- **Site restoration**—Following completion of the remedial actions (active treatment and excavation), injection wells and infiltration galleries will be abandoned and treatment systems will be removed. The areas will be returned to original contours and seeded. Groundwater monitoring wells will remain in place until RAOs are attained.

- **Interim LUCs—**Interim LUCs will consist of the E/PP program and placement of warning signs to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not treated by the remedial action contained in both Alternative 8 or 2 and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

*Alternative 2*:

- **RDSI—**The investigation will be the same as performed for Alternative 8 and will, in part, be considered the Final Characterization used by the FFA parties to determine whether to implement Alternative 8 or 2. Results from the investigation will be used to refine the presence of source areas and contaminant concentrations that will allow the time to attain RGs to be determined. For efficiency, data that is necessary to support the design and implementation of the either Alternative 2 or Alternative 8 will be collected.

- **Groundwater monitoring—**Groundwater sampling and testing will be performed prior to, during, and following the remediation to determine what concentration and type of contaminants are present in the groundwater and if groundwater contaminant levels are changing.

- **Interim LUCs—**Interim LUCs will consist of the E/PP program and placement of warning signs to provide notice and warning of environmental contamination. They are necessary for any VOC and non-VOC contamination at the sites and where concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

**Oil Landfarm—SWMU 1**

*Alternative 3*:

Alternative 3—*In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs (Figures 8 and 9) will be implemented at the Oil Landfarm and will be composed of the following components.

- **RDSI**—An RDSI would be performed at the Oil Landfarm to determine the extent and distribution of VOCs and source material. The investigation will determine UCRS soil and groundwater parameters specific to the reagent being injected during the soil mixing operations. The extent and distribution of VOCs in the UCRS would impact the spacing/locations and depths of the augered areas. The amount and type of potential reagents will be based on RDSI sampling results. In addition, steam injection will be considered for use to enhance the reagent’s ability to treat VOCs. Based on the calculated RGs for VOC concentrations in source area soil, the RDSI would include field data collection to delineate the lateral and vertical extent of VOC contamination at the Oil Landfarm.

- **Injection and mixing of reagent**—Deep soil mixing would be performed using an LDA. A single auger mixing process is assumed for costing purposes. At the Oil Landfarm, an approximate depth of 60 ft would be required. As the auger is advanced into the soil, a slurry would be pumped through the hollow stem of the shaft and injected into the soil at the tip. The auger would be rotated and raised and the mixing blades on the shaft would blend the soil and the slurry. When the design depth is reached, the auger would be withdrawn, and the mixing process would be repeated on the way back to the surface. This mixing technique would be repeated, as necessary, in each boring. Use of steam to facilitate VOC removal may be part of this alternative.

- **Confirmatory sampling**—Confirmatory sampling in the treatment area would be required to determine post treatment TCE soil concentrations. A confirmatory sampling plan would be prepared during RAWP development. The conceptual design for confirmatory sampling includes soil coring using DPT and analysis for VOCs using EPA SW-846 Method 8260B or equivalent. Depths and locations of cores would be determined based on the results of the RDSI.

- **Secondary waste management**—The addition of material to the subsurface could cause expansion of *in situ* material during deep soil mixing. This expansion could result in the generation of secondary waste spoils (e.g., soil, reagent, grout, and water mixture). All secondary wastes would be managed in accordance with ARARs.

- **Site restoration**—Surface restoration following this remedial action would include placement of topsoil and vegetation at the Oil Landfarm. The site would be graded to promote runoff, and a land survey would be conducted to produce topographic as-built drawings.

- **Groundwater monitoring**—Groundwater monitoring would be used to determine the effectiveness of the remedy. One upgradient and three downgradient wells, screened in the shallow RGA, were used for cost estimating purposes at each source area. The actual well quantity, location, and screened interval would be included in the Remedial Design Report and RAWP so that monitoring network design can make use of information made available from the RDSI.

- **Interim LUCs**—Interim LUCs will consist of the E/PP program and placement of warning signs to provide notice and warning of environmental contamination. They are necessary for any VOC and non-VOC contamination at the sites and where concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

Through the implementation of the selected remedies, each of the RAOs for this remedial action will be addressed. Alternatives 3 and 8 meet the RAOs consistent with the NCP. In 40 *CFR* § 300.430(a)(1)(iii)(A), an expectation is established to use treatment to address PTW wherever practicable. Following the Final Characterization of the C-720 Building SWMUs 211-A and 211-B, the FFA parties will determine if there is sufficient TCE contamination present to warrant an active treatment and will implement Alternative 8 if there is, or Alternative 2 if there is not.

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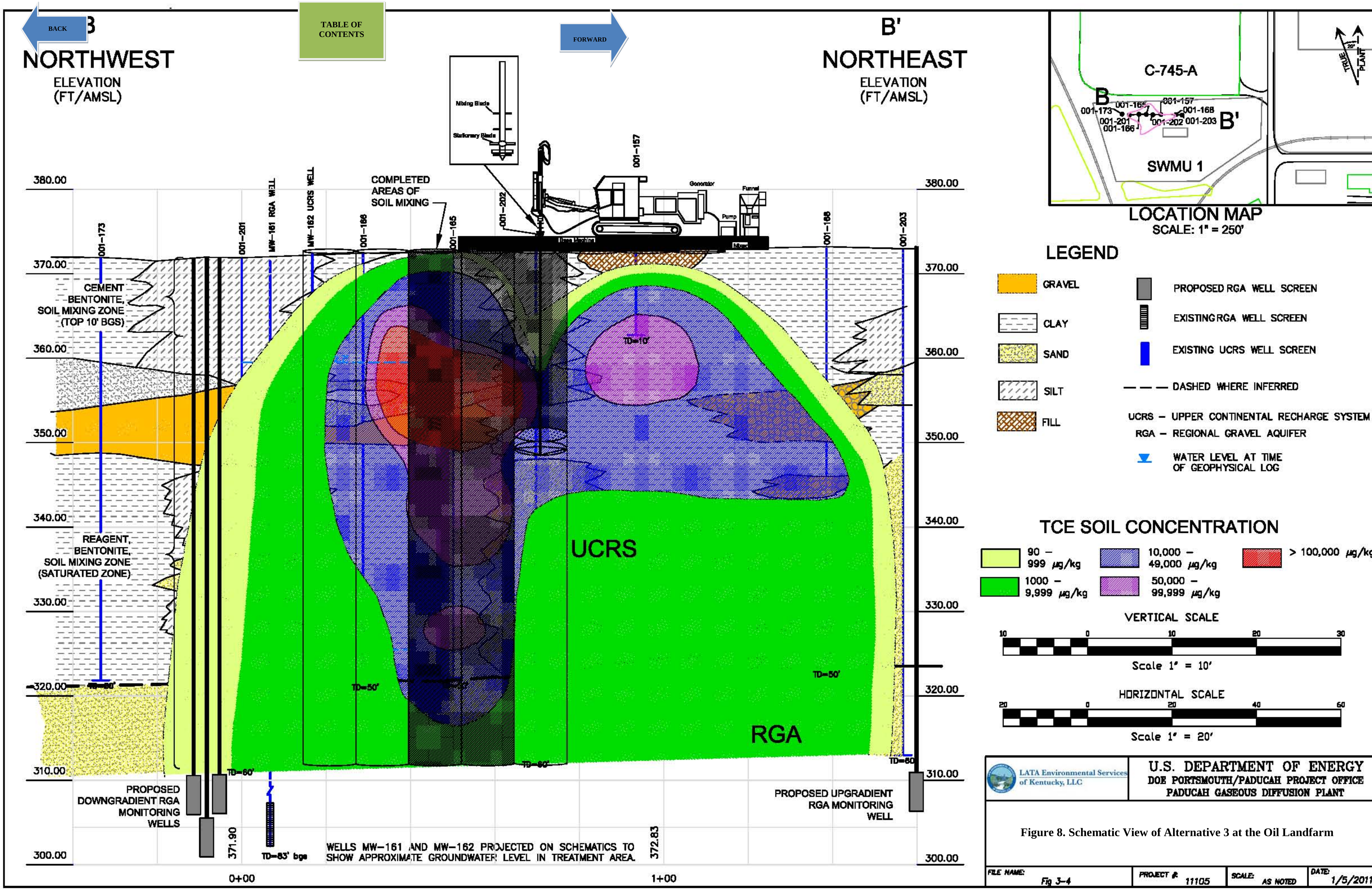


Figure 8. Schematic View of Alternative 3 at the Oil Landfarm

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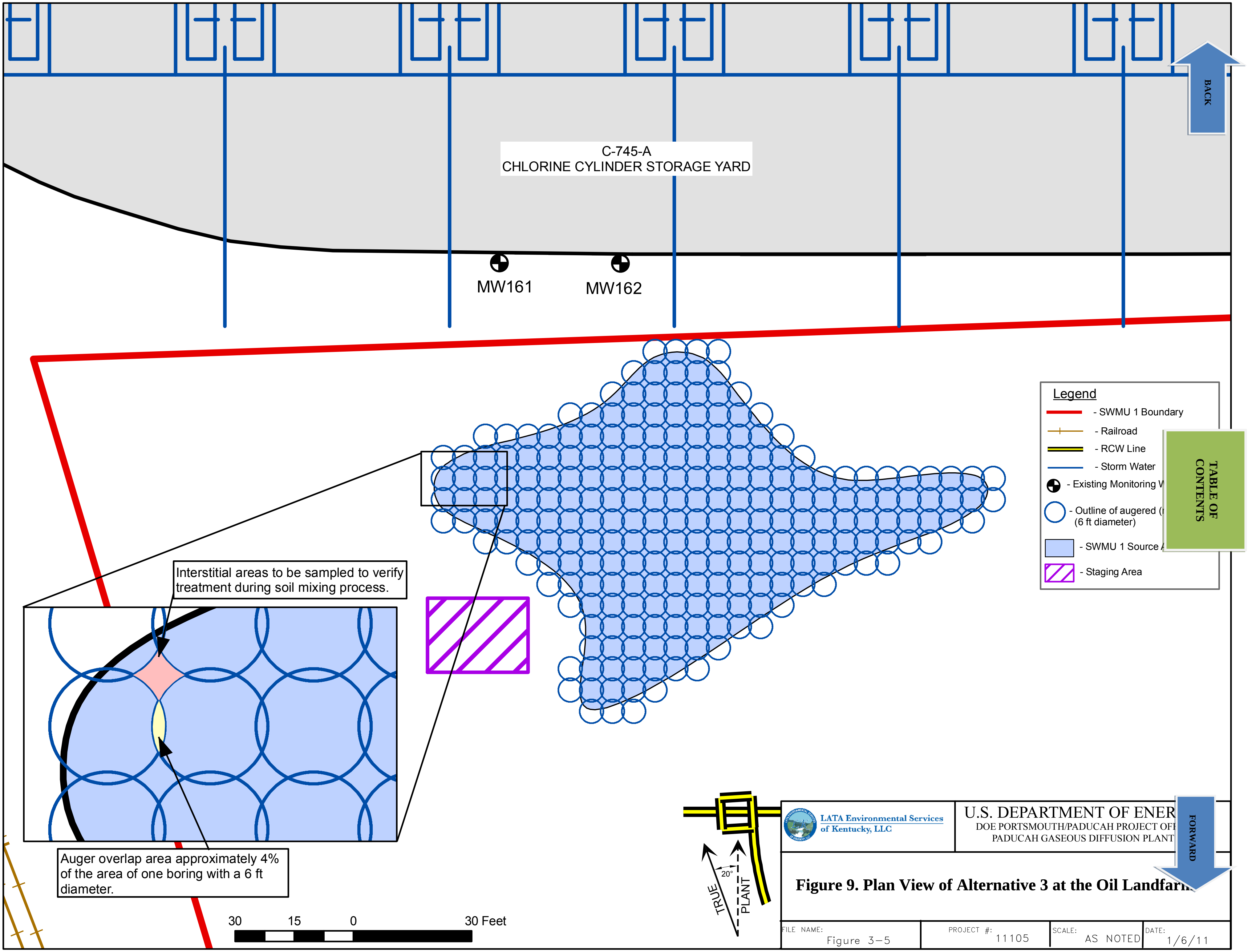

Figure 9. Plan View of Alternative 3 at the Oil Landfarm

***Oil Landfarm***—RAO 1 would be met by using deep soil mixing to mobilize the contaminant and then destroying it with oxidative or biological reactions or capturing it on activated carbon for destruction off-site. RAO 2a and 2b would be met through the use of interim LUCs. The E/PP Program warning signs would protect workers and the public until RAOs were attained, thus meeting RAO 2b. RAO 3 would be met by reducing VOC soil concentrations to groundwater protection RGs through a combination of active remediation and advective attenuation. Modeling results indicate that after active treatment, residual VOC mass will leach to groundwater in the RGA and attain sub-MCL levels within 68 years at the C-747-C Oil Landfarm.

***C-720 Building SWMUs 211-A and 211-B***—RAO 1 would be met by using biological reaction to destroy contaminant using EISB. However, if the mass of TCE determined to be present at each of the C-720 sites, as a result of the FC/RDSI does not warrant active treatment then RAO 1 is not applicable. RAO 2a and 2b would be met through the use of interim LUCs. The E/PP Program warning signs would protect workers and the public until RAOs were attained, thus meeting RAO 2b. RAO 3 would be met by reducing VOC soil concentrations to groundwater protection RGs through biological remediation or advective attenuation. Modeling results indicate that after active treatment, residual VOC mass will leach to groundwater in the RGA and attain sub-MCL levels within 83 years if Alternative 8 is utilized and >100 if Alternative 2 is implemented at the C-720 Northeast and Southeast Sites.

Preparation of the Final Characterization work plans, RDSI work plans, and remedial designs necessary to implement Alternatives 3 and 2 or 8 will follow the completion and signing of this ROD. Additionally, the RDWP will contain information regarding implementation of the FC/RDSI and development of the remedial design report and remedial action work plan. The Remedial Design Report will include criteria setting forth the requirements and approach that will determine when operation of the treatment systems will cease. The Operations Plan will include a compliance plan that incorporates a discussion of substantive requirements that the action will meet and the administrative requirements that are exempted for the action due to its CERCLA status.

### 2.11.3 Summary of the Estimated Remedy Cost

Tables 17 and 18 present cost estimate summaries of Alternatives 8 and 2, respectively, for application at the C-720 Building SWMUs 211-A and 211-B. Table 19 presents the cost estimate summaries for the applying Alternative 3 to the Oil Landfarm. These are an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. The information in this cost estimate summary table is based on the best available information regarding the anticipated implementation costs of the remedial alternative. Changes in the cost elements in tables are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative (i.e., in the RAWP), which will include the development of a more detailed project cost estimate breakdown. Significant cost increases may require reevaluation of the cost effectiveness of the selected remedy. If, after this ROD is signed, DOE anticipates that, for any reason, the cost of the selected remedy will exceed by a significant amount the cost estimate in the ROD, that increase will be documented, with appropriate public notice, in accordance with Section 300.435(c)(2) of the NCP.

**Table 17. Summary of Estimated Costs for Alternative 8**

| Cost element[1] | C-720 Northeast Site ($M) | C-720 Southeast Site ($M) |
|---|---|---|
| **Unescalated Cost** | | |
| Capital cost | $2.3 | $3.0 |
| O&M | $1.3 | $1.4 |
| **Subtotal** | $3.7 | $4.4 |
| **Escalated Cost** | | |
| Capital cost | $2.5 | $3.2 |
| O&M | $2.2 | $2.2 |
| **Subtotal** | $4.7 | $5.4 |
| **Present Worth[2]** | | |
| Capital cost | $2.3 | $3.0 |
| O&M | $1.0 | $1.0 |
| **Subtotal** | $3.3 | $4.0 |

[1]Includes general and administrative fee and 25% contingency.
[2]Present worth costs are based on an assumption that out-year costs will be financed by investments made in year 0 and are provided for purposes of comparison only. The discount rate used for calculation of present worth was 2.3%. Escalated costs are used by DOE for planning and budgeting.

**Table 18. Summary of Estimated Costs for Alternative 2**

| Cost element[1] | C-720 Northeast Site ($M) | C-720 Southeast Site ($M) |
|---|---|---|
| **Unescalated Cost** | | |
| Capital cost | $1.0 | $1.0 |
| O&M | $1.2 | $1.2 |
| **Subtotal** | $2.2 | $2.2 |
| **Escalated Cost** | | |
| Capital cost | $1.1 | $1.1 |
| O&M | $2.1 | $2.1 |
| **Subtotal** | $3.2 | $3.2 |
| **Present Worth[2]** | | |
| Capital cost | $1.0 | $1.0 |
| O&M | $0.9 | $0.9 |
| **Subtotal** | $1.9 | $1.9 |

[1]Includes general and administrative fee and 25% contingency.
[2]Present worth costs are based on an assumption that out-year costs will be financed by investments made in year 0 and are provided for purposes of comparison only. The discount rate used for calculation of present worth was 2.3%. Escalated costs are used by DOE for planning and budgeting.

**Table 19. Summary of Estimated Costs for Alternative 3**

| Cost element[1] | Oil Landfarm ($M) |
|---|---|
| **Unescalated Cost** | |
| Capital cost | $9.5 |
| O&M | $1.1 |
| **Total** | $10.6 |
| **Escalated Cost** | |
| Capital cost | $10.0 |
| O&M | $1.9 |
| **Total** | $11.9 |
| **Present Worth[2]** | |
| Capital cost | $9.5 |
| O&M | $0.8 |
| **Total** | $10.3 |

[1]Includes general and administrative fee and 15% contingency.
[2]Present worth costs are based on an assumption that out-year costs will be financed by investments made in year 0 and are provided for purposes of comparison only. The discount rate used for calculation of present worth was 2.3%. Escalated costs are used by DOE for planning and budgeting.

### 2.11.4 Expected Outcomes of the Selected Remedy

**Oil Landfarm—SWMU 1**

Alternative 3 will treat the source zone comprised of TCE and other VOCs at the C-747-C Oil Landfarm using deep soil mixing. After active treatment, residual VOC mass (estimated at 9%) will leach to groundwater in the RGA and attain sub-MCL levels within 68 years at the C-747-C Oil Landfarm.

**C-720 Building—SWMUs 211-A and 211-B**

Alternative 8, if implemented, will treat the source zones at the SWMUs to biologically remediate the TCE sources and other VOCs. After the active bioremediation treatment, residual VOC mass (estimated at 40%) will leach to groundwater in the RGA and attain the sub-MCL levels within 83 years.

Alternative 2 does not include active treatment, but will provide a basis for monitoring contaminant attenuation. Sub-MCL values for TCE leaching to the RGA are expected to be attained within 97 years at the C-720 Northeast and Southeast Sites. Both Alternative 8 and 2 also provide for protection of human health through the implementation of interim LUCs.

## 2.12 STATUTORY DETERMINATION

Under CERCLA §121 and the NCP, DOE as the lead agency, must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

### 2.12.1 Overall Protection of Human Health and the Environment

The selected remedies, Alternatives 8 and 2 at SWMUs 211-A and 211-B and Alternative 3 at SWMU 1 are protective of human health and the environment, and will attain the RAOs in an estimated 83, 97, and 68 years, respectively. Additionally, the implementation of interim LUCs in both alternatives will prevent human exposure to non-VOC and residual VOC contamination until RAOs are attained.

### 2.12.2 Compliance with ARARs

Alternatives 8, 2, and 3 comply with ARARs for the scope of this action. The ARARs are presented in Table A.1.

### 2.12.3 Cost Effectiveness

Based on the current assumptions and cost estimates, Alternatives 2 and 8 at SWMUs 211-A and 211-B and Alternative 3 at SWMU 1 are cost-effective and represent a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." [NCP 300.430(f)(1)(ii)(D)] Overall effectiveness was evaluated by assessing the five balancing criteria. The estimated total escalated cost of each Alternative is as follows:

- Alternative 8—SWMUs 211-A and 211-B—$10.1M
- Alternative 2—SWMUs 211-A and 211-B—$6.4M
- Alternative 3—SWMU 1—$11.9M

DOE believes that Alternatives 8, 2, and 3 will provide a reduction in concentrations of TCE and other VOCs in soil in the three source zones at a lower cost relative to the other more costly alternatives and still will provide attainment of the RAOs.

### 2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Depending on results of FC, Alternatives 8 or 2 at SWMUs 211-A and 211-B represent the best balance among the alternatives evaluated with respect to balancing and modifying criteria for remedy selection. Alternative 3 at SWMU 1 represent the best balance of trade-offs among alternatives with respect to pertinent criteria, given the limited scope of the action. This remedial action supports the CERCLA preference for treatment by destruction of contaminant mass by bioremediation with Alternative 8 at SWMUs 211-A and 211-B and by deep soil mixing at SWMU 1. Alternative 8 treats the source materials comprised of VOCs at the SWMUs 211-A and 211-B, and Alternative 3 at SWMU 1 achieves significant reductions in the concentrations of VOCs in the source areas and satisfy the criterion for long-term effectiveness to the extent possible in a reasonable time frame. None of the three alternatives present short-term risks different from the other treatment alternatives, and all alternatives are more implementable compared to the other alternatives.

### 2.12.5 Preference for Treatment as a Principal Element

By treating the soils contaminated with TCE and other VOCs with deep soil mixing at the Oil Landfarm and with Enhanced *In Situ* Bioremediation, Alternatives 3 and 8 address contamination at SWMU 1, SWMU 211-A, and 211-B source areas using treatment technology. If Long-term Monitoring is selected for implementation at either SWMU 211-A or 211-B, contaminant volumes will be reduced through dispersion, source depletion, and degradation. The selected remedies satisfy the CERCLA preference for remedies that employ treatment as a principal element is satisfied.

## 2.13 FIVE-YEAR REVIEW

Because all three alternatives will result in hazardous substances, pollutants, or contaminants remaining on-site for up to 97 years at levels above those that allow for unlimited use and unrestricted exposure, a statutory review will be conducted no less often than once every five years in accordance with CERCLA Section 121(c) and NCP § 300.430(f)(5)(iii)(C). The reviews are conducted to ensure that the remedy is, or will be, protective of human health and the environment.

## 2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The *Revised Proposed Plan 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/07-0363&D2, was made available for a 45-day public review and comment period TBD through TBD. The PP identified Alternative 8, *In Situ* Source Treatment Using EISB with Interim LUCs, or Alternative 2, Long-Term Monitoring with Interim LUCs, as the preferred alternatives for SWMUs 211-A and 211-B, and Alternative 3, *In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs, as the preferred alternative for SWMU 1. After review and consideration of the comments received during that public review and comment period, it has been determined that no significant changes to the preferred alternatives are necessary or appropriate.

# PART 3

# RESPONSIVENESS SUMMARY

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# PART 3. RESPONSIVENESS SUMMARY

## 3.1 RESPONSIVENESS SUMMARY INTRODUCTION

## 3.2 COMMUNITY PREFERENCES/INTEGRATION OF COMMENTS

Information to be added once Proposed Plan undergoes Public Review.

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# APPENDIX A

# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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**Table A.1. Location-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites**

| Location-specific ARARs | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Requirement** | **Prerequisite** | **Citation** | **SWMU 1** | **C-720 NE** | **C-720 SE** |
| ***Cultural resources*** | | | | | | |
| Presence of wetlands as defined in 10 *CFR* § 1022.4 | Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands. | DOE actions that involve potential impacts to, or take place within, wetlands—**applicable**. | 10 *CFR* § 1022.3(a) | ü | ü | ü |
| | Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. | | 10 *CFR* § 1022.3(a)(7) and (8) | ü | ü | ü |
| | Undertake a careful evaluation of the potential effects of any new construction in wetlands. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands. | | 10 *CFR* § 1022.3(b) and (d) | ü | ü | ü |
| | Measures that mitigate the adverse effects of actions in a wetland including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-sensitive areas. | | 10 *CFR* § 1022.13(a)(3) | ü | ü | ü |
| | If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in E.O. 11990. | | 10 *CFR* § 1022.14(a) | ü | ü | ü |
| Location encompassing aquatic ecosystem as defined in 40 *CFR* § 230.3(c) | Except as provided under section 404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States. | Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**relevant and appropriate**. | 40 *CFR* § 230.10(a) and (c) | ü | ü | ü |

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**Table A.1. Location-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Location-specific ARARs | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Requirement** | **Prerequisite** | **Citation** | **SWMU 1** | **C-720 NE** | **C-720 SE** |
| | Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 *CFR* § 230.70 *et seq*. identifies such possible steps. | | 40 *CFR* § 230.10(d) | ü | ü | ü |
| Nationwide Permit Program | Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate. | Discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**relevant and appropriate**. | Nation Wide Permit (38) Cleanup of Hazardous and Toxic Waste<br>33 *CFR* § 323.3(b) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | ***Site preparation, construction, and excavation activities*** | | | | | |
| Activities causing fugitive dust emissions | No person shall cause, suffer, or allow any material to be handled, processed, transported, or stored, a building or its appurtenances to be constructed, altered, repaired, or demolished, or a road to be used without taking reasonable precaution to prevent particulate matter from becoming airborne. Such reasonable precautions shall include, when applicable, but not be limited to, the following:<br>· Use, where possible, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land;<br>· Application and maintenance of asphalt, oil, water, or suitable chemicals on roads, materials stockpiles, and other surfaces which can create airborne dusts;<br>· Covering, at all times when in motion, open bodied trucks transporting materials likely to become airborne;<br>· The maintenance of paved roadways in a clean condition; and<br>· The prompt removal of earth or other material from a paved street which earth or other material has been transported thereto by trucking or earth moving equipment or erosion by water. | Fugitive emissions from land-disturbing activities (e.g., handling, processing, transporting or storing of any material, demolition of structures, construction operations, grading of roads, or the clearing of land, etc.)¾ **applicable**. | 401 *KAR* 63:010 § 3(1) and (1)(a), (b), (d), (e) and (f) | | ü | ü |
| | No person shall cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate. | | 401 *KAR* 63:010 § 3(2) | | ü | ü |
| Activities causing radionuclide emissions | Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem/yr. | Radionuclide emissions from point sources at a DOE facility¾ **applicable**. | 40 *CFR* § 61.92<br>401 *KAR* 57:002 | | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Activities causing toxic substances or potentially hazardous matter emissions | Persons responsible for a source from which hazardous matter or toxic substances may be emitted shall provide the utmost care and consideration in the handling of these materials to the potentially harmful effects of the emissions resulting from such activities. No owner or operator shall allow any affected facility to emit potentially hazardous matter or toxic substances in such quantities or duration as to be harmful to the health and welfare of humans, animals and plants. | Emissions of potentially hazardous matter or toxic substances as defined in 401 *KAR* 63:020 § 2 (2) ¾ **applicable**. | 401 *KAR* 63:020 § 3 | | ü | ü |
| Activities causing storm water runoff (e.g., clearing, grading, excavation) | Implement good construction techniques to control pollutants in storm water discharges during and after construction in accordance with substantive requirements provided by permits issued pursuant to 40 *CFR* § 122.26(c). | Storm water discharges associated with small construction activities as defined in 40 *CFR* § 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157)—**applicable**. | 40 *CFR* § 122.26(c)(1)(ii)(C) and (D)<br>401 *KAR* 5:060 § 8 | ü | ü | ü |
| | Storm water runoff associated with construction activities taking place at a facility with an existing Best Management Practices (BMP) Plan shall be addressed under the facility BMP and not under a storm water general permit. | Storm water discharges associated with small construction activities as defined in 40 *CFR* § 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157)—**TBC**. | Fact Sheet for the KPDES General Permit For Storm water Discharges Associated with Construction Activities, June 2009 | ü | ü | ü |
| | Best management storm water controls will be implemented and may include, as appropriate, erosion and sedimentation control measures, structural practices (e.g., silt fences, straw bale barriers) and vegetative practices (e.g., seeding); storm water management (e.g., diversion); and maintenance of control measures in order to ensure compliance with the standards in Section C.5. Storm Water Discharge Quality. | Storm water runoff associated with construction activities taking place at a facility [PGDP] with an existing BMP Plan—**TBC**. | Appendix C of the PGDP Best Management Practices Plan (2007)—Examples of Storm water Controls | ü | ü | ü |



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Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| ***Monitoring, Extraction, and Injection Well Installation and Abandonment*** | | | | | | |
| 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) | ü | ü | ü |
| | All permanent (including boreholes) shall be constructed to comply with the substantive requirements provided in the following Sections of 401 *KAR* 6:350:<br>· Section 2. Design Factors;<br>· Section 3. Monitoring Well Construction;<br>· Section 7. Materials for Monitoring Wells; and<br>· Section 8. Surface Completion. | | 401 *KAR* 6:350 § 2, 3, 7, and 8 | ü | ü | ü |
| | 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.<br>*NOTE: Variance shall be made as part of the FFA CERCLA document review and approval process and shall include:*<br>· A justification for the variance; and<br>· 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 § 1(6)(a)(6) and (7) | ü | ü | ü |



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## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Development of monitoring well | Newly installed wells shall be developed until the column of water in the well is free of visible sediment.<br>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 | ü | ü | ü |
| 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) | ü | ü | ü |
| | Shall also comply with the following additional standards:<br>(a) The outside diameter of the borehole shall be a minimum of 1 inch greater than the outside diameter of the well casing;<br>(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<br>(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) | ü | ü | ü |
| 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) | ü | ü | ü |
| | 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) | ü | ü | ü |

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## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | 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) | ü | ü | ü |
| 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 monitoring well for remedial action—**relevant and appropriate**. | 401 *KAR* 6:350 § 1 (2) | | | |
| Reinjection of treated contaminated groundwater, or, injection of bioamendments, surfactants, or reagents | No owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 *CFR* Part 142 or may otherwise adversely affect the health of persons. | Underground injection into an underground source of drinking water—**relevant and appropriate**. | 40 *CFR* § 144.12(a) | | ü | ü |
| Reinjection of treated contaminated groundwater | Wells are not prohibited if injection is approved by EPA or a State pursuant to provisions for cleanup of releases under CERCLA or RCRA *as provided in the FFA CERCLA document*. | Class IV wells [as defined in 40 *CFR* § 144.6(d)] used to reinject treated contaminated groundwater into the same formation from which it was drawn—**relevant and appropriate**. | 40 *CFR* § 144.13(c)<br>RCRA § 3020(b) | | | ü |
| | Prior to abandonment any Class IV well, the owner or operator shall plug or otherwise close the well in a manner *as provided in the FFA CERCLA document*. | Class IV wells [as defined in 40 *CFR* § 144.6(d)] used to reinject of treated contaminated groundwater into the same formation from which it was drawn—**relevant and appropriate**. | 40 *CFR* § 144.23(b)(1) | | | |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Plugging and abandonment of Class IV injection wells | Prior to abandoning the well, the owner or operator shall close the well in accordance with 40 *CFR* § 144.23(b). | Operation of a Class IV injection well [as defined in 40 *CFR* § 144.6(d)]—**relevant and appropriate**. | 40 *CFR* § 146.10(b) | | | ü |
| Injection of bioamendments, surfactants, or reagents | An injection activity cannot allow the movement of fluid containing any contaminant into USDWs, if the presence of that contaminant may cause a violation of the primary drinking water standards under 40 *CFR* part 141, other health based standards, or may otherwise adversely affect the health of persons. This prohibition applies to well construction, operation, maintenance, conversion, plugging, closure, or any other injection activity. | Class V wells [as defined in 40 *CFR* § 144.6(e)] used to inject bioamendments, surfactants, or reagents—**relevant and appropriate**. | 40 *CFR* § 144.82(a)(1) | | ü | |
| | Wells must be closed in a manner that complies with the above prohibition of fluid movement. Also, any soil, gravel, sludge, liquids, or other materials removed from or adjacent to the well must be disposed or otherwise managed in accordance with substantive applicable Federal, State, and local regulations and requirements. | | 40 *CFR* § 144.82(b) | | ü | ü |
| Management of PCB waste | Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* § 761, Subpart D. | Storage or disposal of waste containing PCBs at concentrations ≥ 50 ppm—**applicable**. | 40 *CFR* § 761.50(a) | ü | ü | ü |
| | Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found. | Cleanup and disposal of PCB remediation waste as defined in 40 *CFR* § 761.3—**applicable**. | 40 *CFR* § 761.61 | ü | ü | ü |
| Management of PCB/Radioactive waste | Any person storing such waste must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* § 761.65(a)(1), (b)(1)(ii) and (c)(6)(i). | Generation of PCB/Radioactive waste with ≥ 50 ppm PCBs for storage—**applicable**. | 40 *CFR* § 761.50(b)(7)(i) | ü | ü | ü |



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## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties.<br>If, taking into account only the properties of the PCBs in the waste (and not the radioactive properties of the waste), the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill [e.g., PCB bulk-product waste under 40 *CFR* § 761.62(b)(1)], then the person may dispose of PCB/radioactive waste, without regard to the PCBs, based on its radioactive properties in accordance with applicable requirements for the radioactive component of the waste. | Generation of PCB/radioactive waste with ³ 50 ppm PCBs for disposal¾ **applicable**. | 40 *CFR* § 761.50(b)(7)(ii) | ü | ü | ü |
| ***Waste Characterization*** | | | | | | |
| Characterization of solid waste | Must determine if solid waste is excluded from regulation under 40 *CFR* § 261.4. | Generation of solid waste as defined in 40 *CFR* § 261.2—**applicable**. | 40 *CFR* § 262.11(a)<br>401 *KAR* 32:010 § 2 | ü | ü | ü |
| | Must determine if waste is listed as a hazardous waste in subpart D of 40 *CFR* Part 261. | Generation of solid waste which is not excluded under 40 *CFR* § 261.4—**applicable**. | 40 *CFR* § 262.11(b)<br>401 *KAR* 32:010 § 2 | ü | ü | ü |
| | Must determine whether the waste is characteristic waste (identified in subpart C of 40 *CFR* Part 261) by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used. | Generation of solid waste that is not listed in subpart D of 40 *CFR* Part 261 and not excluded under 40 *CFR* § 261.4—**applicable**. | 40 *CFR* § 262.11(c)<br>401 *KAR* 32:010 § 2 | ü | ü | ü |
| | Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste. | Generation of solid waste which is determined to be hazardous waste—**applicable**. | 40 *CFR* § 262.11(d)<br>401 *KAR* 32:010 § 2 | ü | ü | ü |



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Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Characterization of hazardous waste | Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 *CFR* §§ 264 and 268. | Generation of RCRA-hazardous waste for storage, treatment or disposal—**applicable**. | 40 *CFR* § 264.13(a)(1)<br>401 *KAR* 34:020 § 4 | ü | ü | ü |
| Characterization of industrial wastewater | Industrial wastewater discharges that are point source discharges subject to regulation under section 402 of the Clean Water Act, as amended, are not solid wastes for the purpose of hazardous waste management.<br>[Comment: This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment.]<br>NOTE: For purpose of this exclusion, the CERCLA on-site treatment system for extracted VOCs and groundwater will be considered equivalent to a wastewater treatment unit and the point source discharges subject to regulation under CWA Section 402, provided the effluent meets all identified CWA ARARs. | Generation of industrial wastewater for treatment and discharge into surface water¾ **applicable**. | 40 *CFR* § 261.4(a)(2)<br>401 *KAR* 31:010 § 4 | | | |
| Determinations for management of hazardous waste | Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* § 268.40 *et. seq*.<br>*Note:* This determination may be made concurrently with the hazardous waste determination required in 40 *CFR* § 262.11. | Generation of hazardous waste—**applicable**. | 40 *CFR* § 268.9(a)<br>401 *KAR* 37:010 § 8 | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Must determine the underlying hazardous constituents [as defined in 40 *CFR* § 268.2(i)] in the characteristic waste. | Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal—**applicable**. | 40 *CFR* § 268.9(a)<br>401 *KAR* 37:010 § 8 | ü | ü | ü |
| | Must determine if the hazardous waste meets the treatment standards in 40 *CFR* §§ 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste.<br>*Note:* This determination can be made concurrently with the hazardous waste determination required in 40 *CFR* § 262.11. | Generation of hazardous waste—**applicable**. | 40 *CFR* § 268.7(a)<br>401 *KAR* 37:010 § 7 | ü | ü | ü |
| Characterization of LLW | Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility. | Generation of LLW for storage and disposal at a DOE facility—**TBC**. | DOE M 435.1-1(IV)(I) | ü | ü | ü |
| | Characterization data shall, at a minimum, include the following information relevant to the management of the waste: | | DOE M 435.1-1(IV)(I)(2) | ü | ü | ü |
| | · physical and chemical characteristics; | | DOE M 435.1-1(IV)(I)(2)(a) | ü | ü | ü |
| | · volume, including the waste and any stabilization or absorbent media; | | DOE M 435.1-1(IV)(I)(2)(b) | ü | ü | ü |
| | · weight of the container and contents; | | DOE M 435.1-1(IV)(I)(2)(c) | ü | ü | ü |
| | · identities, activities, and concentration of major radionuclides; | | DOE M 435.1-1(IV)(I)(2)(d) | ü | ü | ü |
| | · characterization date; | | DOE M 435.1-1(IV)(I)(2)(e) | ü | ü | ü |

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Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | | ***Waste Storage*** | | | | |
| | · generating source; and | | DOE M 435.1-1(IV)(I)(2)(f) | ü | ü | ü |
| | · any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives. | | DOE M 435.1-1(IV)(I)(2)(g) | ü | ü | ü |
| Temporary on-site storage of hazardous waste in containers | A generator may accumulate hazardous waste at the facility provided that | Accumulation of RCRA hazardous waste on-site as defined in 40 *CFR* § 260.10—**applicable**. | 40 *CFR* § 262.34(a)<br>401 *KAR* 32:030 § 5 | ü | ü | ü |
| | · waste is placed in containers that comply with 40 *CFR* § 265.171-173; | | 40 *CFR* § 262.34(a)(1)(i)<br>401 *KAR* 32:030 § 5 | ü | ü | ü |
| | · the date upon which accumulation begins is clearly marked and visible for inspection on each container; and | | 40 *CFR* § 262.34(a)(2)<br>401 *KAR* 32:030 § 5 | ü | ü | ü |
| | · container is marked with the words "hazardous waste." | | 40 *CFR* § 262.34(a)(3)<br>401 *KAR* 32:030 § 5 | ü | ü | ü |
| | Container may be marked with other words that identify the contents. | Accumulation of 55 gal or less of RCRA hazardous waste or one quart of acutely hazardous waste listed in 261.33(e) at or near any point of generation—**applicable**. | 40 *CFR* § 262.34(c)(1)<br>401 *KAR* 32:030 § 5 | ü | ü | ü |



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### Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Use and management of containers holding hazardous waste | If container is not in good condition or if it begins to leak, must transfer waste into container in good condition. | Storage of RCRA hazardous waste in containers—**applicable**. | 40 *CFR* § 265.171<br>401 *KAR* 35:180 § 2 | ü | ü | ü |
| | Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired. | | 40 *CFR* § 265.172<br>401 *KAR* 35:180 § 3 | ü | ü | ü |
| | Keep containers closed during storage, except to add/remove waste. | | 40 *CFR* § 265.173(a)<br>401 *KAR* 35:180 § 4 | ü | ü | ü |
| | Open, handle and store containers in a manner that will not cause containers to rupture or leak. | | 40 *CFR* § 265.173(b)<br>401 *KAR* 35:180 § 4 | ü | ü | ü |
| Storage of hazardous waste in container area | Area must have a containment system designed and operated in accordance with 40 *CFR* § 264.175(b). | Storage of RCRA hazardous waste in containers with free liquids—**applicable**. | 40 *CFR* § 264.175(a) | ü | ü | ü |
| | · Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or<br>· Containers must be elevated or otherwise protected from contact with accumulated liquid. | Storage of RCRA-hazardous waste in containers that do not contain free liquids (other than F020, F021, F022, F023,F026 and F027)—**applicable**. | 40 *CFR* § 264.175(c) | ü | ü | ü |
| Storage of PCB waste and/or PCB/radioactive waste in a RCRA-regulated container storage area | Does not have to meet storage unit requirements in 40 *CFR* § 761.65(b)(1) provided unit. | Storage of PCBs and PCB Items at concentrations ≥ 50ppm designated for disposal—**applicable**. | 40 *CFR* § 761.65(b)(2) | ü | ü | ü |

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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | · is permitted by EPA under RCRA § 3004 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761; | | 40 *CFR* § 761.65(b)(2)(i) | ü | ü | ü |
| | · qualifies for interim status under RCRA § 3005 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761; or | | 40 *CFR* § 761.65(b)(2)(ii) | ü | ü | ü |
| | · is permitted by an authorized state under RCRA § 3006 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761. | | 40 *CFR* § 761.65(b)(2)(iii) | ü | ü | ü |
| | NOTE: For purpose of this exclusion, CERCLA remediation waste, which is also considered PCB waste, can be stored on-site provided the area meets all of the identified RCRA container storage ARARs and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761. | | | | | |
| Storage of PCB waste and/or PCB/radioactive waste in non-RCRA regulated unit | Except as provided in 40 *CFR* § 761.65 (b)(2), (c)(1), (c)(7), (c)(9), and (c)(10), after July 1, 1978, owners or operators of any facilities used for the storage of PCBs and PCB Items designated for disposal shall comply with the storage unit requirements in 40 *CFR* § 761.65(b)(1). | Storage of PCBs and PCB Items at concentrations ≥ 50ppm designated for disposal¾ **applicable**. | 40 *CFR* § 761.65(b) | ü | ü | ü |
| | Storage facility shall meet the following criteria:<br>· Adequate roof and walls to prevent rainwater from reaching stored PCBs and PCB items; | | 40 *CFR* § 761.65(b)(1)<br>40 *CFR* § 761.65(b)(1)(i) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | · Adequate floor that has continuous curbing with a minimum 6-inch high curb. Floor and curb must provide a containment volume equal to at least two times the internal volume of the largest PCB article or container or 25% of the internal volume of all articles or containers stored there, whichever is greater. *Note*: 6 inch minimum curbing not required for area storing PCB/radioactive waste; | | 40 *CFR* § 761.65(b)(1)(ii) | ü | ü | ü |
| | · No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from curbed area; | | 40 *CFR* § 761.65(b)(1)(iii) | ü | ü | ü |
| | · Floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, non-porous surface that prevents or minimizes penetration of PCBs; and | | 40 *CFR* § 761.65(b)(1)(iv) | ü | ü | ü |
| | · Not located at a site that is below the 100-year flood water elevation. | | 40 *CFR* § 761.65(b)(1)(v) | ü | ü | ü |
| | Storage area must be properly marked as required by 40 *CFR* § 761.40(a)(10). | | 40 *CFR* § 761.65(c)(3) | ü | ü | ü |
| Risk-based storage of PCB remediation waste | May store PCB remediation waste in a manner other than prescribed in 40 *CFR* § 761.65(b) if approved in writing from EPA provided the method will not pose an unreasonable risk of injury to human health or the environment.<br>*NOTE:* EPA approval of alternative storage method will be obtained by approval of the FFA CERCLA document. | Storage of waste containing PCBs in a manner other than prescribed in 40 *CFR* § 761.65(b) (see above) ¾ **applicable**. | 40 *CFR* § 761.61(c) | ü | ü | ü |
| Temporary storage of PCB waste (e.g., PPE, rags) in a container(s) | Container(s) shall be marked as illustrated in 40 *CFR* § 761.45(a). | Storage of PCBs and PCB items at concentrations ≥ 50ppm in containers for disposal—**applicable**. | 40 *CFR* § 761.40(a)(1) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Storage area must be properly marked as required by 40 *CFR* § 761.40(a)(10). | | 40 *CFR* § 761.65(c)(3) | ü | ü | ü |
| | Any leaking PCB Items and their contents shall be transferred immediately to a properly marked nonleaking container(s). | | 40 *CFR* § 761.65(c)(5) | ü | ü | ü |
| | Except as provided in 40 *CFR* § 761.65(c)(6)(i) and (c)(6)(ii), container(s) shall be in accordance with requirements set forth in DOT HMR at 49 *CFR* §§ 171-180. | | 40 *CFR* § 761.65(c)(6) | ü | ü | ü |
| Staging of LLW | Shall be for the purpose of the accumulation of such quantities of wastes necessary to facilitate transportation, treatment, and disposal. | Staging of LLW at a DOE facility—**TBC**. | DOE M 435.1-1 (IV)(N)(7) | ü | ü | ü |
| Temporary storage of LLW | Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water. | Temporary storage of LLW at a DOE facility—**TBC**. | DOE M 435.1-1 (IV)(N)(1) | ü | ü | ü |
| | Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage. | | DOE M 435.1-1 (IV)(N)(3) | ü | ü | ü |
| | Shall be managed to identify and segregate LLW from mixed waste. | | DOE M 435.1-1 (IV)(N)(6) | ü | ü | ü |
| Packaging of LLW for storage | Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container. | Storage of LLW in containers at a DOE facility—**TBC**. | DOE M 435.1-1(IV)(L)(1)(a) | ü | ü | ü |
| | Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container. | | DOE M 435.1-1(IV)(L)(1)(b) | ü | ü | ü |
| | Containers shall be marked such that their contents can be identified. | | DOE M 435.1-1(IV)(L)(1)(c) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Packaging of LLW for off-site disposal | Waste shall not be packaged for disposal in a cardboard or fiberboard box. | Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(b) | ü | ü | ü |
| | Liquid waste shall be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid. | Preparation of liquid LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(c) | ü | ü | ü |
| | Solid waste containing liquid shall contain as little freestanding and noncorrosive liquid as is reasonably achievable. The liquid shall not exceed one (1) percent of the volume. | Preparation of solid LLW containing liquid for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(d) | ü | ü | ü |
| | Waste shall not be readily capable of<br>· Detonation;<br>· Explosive decomposition or reaction at normal pressures and temperatures; or<br>· Explosive reaction with water. | Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(e) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to a person transporting, handling, or disposing of the waste. | Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(f) | ü | ü | ü |
| | Waste shall not be pyrophoric. | Packaging of pyrophoric LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**. | 10 *CFR* § 61.56<br>902 *KAR* 100:021 § 7 (1)(g) | ü | ü | ü |
| Labeling of LLW packages | Each package of waste shall be clearly labeled to identify if it is Class A, Class B, or Class C waste, in accordance with 10 *CFR* § 61.55 or Agreement State waste classification requirements. | Preparation for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility¾ **relevant and appropriate**. | 10 *CFR* § 61.57<br>902 *KAR* 100:021 § 8 | ü | ü | ü |
| ***Waste treatment and disposal*** | | | | | | |
| Transport or conveyance of collected RCRA wastewater to a WWTU located on the facility | Any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to an on-site KPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards.<br>*NOTE:* For purposes of this exclusion, any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey CERCLA remediation wastewater to a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a facility, are exempt from the requirements of RCRA Subtitle C standards. | On-site wastewater treatment units (as defined in 40 *CFR* § 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., KPDES-permitted) that manages hazardous wastewaters ¾ **applicable**. | 40 *CFR* § 264.1(g)(6)<br>401 *KAR* 34:010 § 1 | | | |

## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Release of property with residual radioactive material to an off-site commercial facility | Prior to being released, property shall be surveyed to determine whether both removable and total surface contamination (including contamination present on and under any coating) are in compliance with the levels given in Figure IV-1 of DOE O 5400.5 and the contamination has been subjected to the ALARA process. | Generation of DOE materials and equipment with surface residual radioactive contamination—**TBC**. | DOE O 5400.5 (II)(5)(c)(1) and 5400.5(IV)(4)(d) | ü | ü | ü |
| | Material that has been radioactively contaminated in depth may be released if criteria and survey techniques are approved by DOE EH-1. | Generation of DOE materials and equipment that are volumetrically contaminated with radionuclides—**TBC**. | DOE O 5400.5 (II)(5)(c)(6) | ü | ü | ü |
| ***Discharge of Wastewater from Groundwater Treatment System*** | | | | | | |
| General duty to mitigate for discharge of wastewater from groundwater treatment system | Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has a reasonable likelihood of adversely affecting human health or the environment. | Discharge of pollutants to surface waters—**applicable**. | 401 *KAR* 5:065 § 2(1) and 40 *CFR* § 122.41(d) | | | |
| Operation and maintenance of treatment system | Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with the effluent standards. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. | Discharge of pollutants to surface waters—**applicable**. | 401 *KAR* 5:065 § 2(1) and 40 *CFR* § 122.41(e) | | | |
| Criteria for discharge of wastewater with radionuclides into surface water | To prevent the buildup of radionuclide concentrations in sediments, liquid process waste streams containing radioactive material in the form of settleable solids may be released to natural waterways if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (O.2 Bq) per gram above background level, of settleable solids for alpha-emitting radionuclides or 50 pCi (2 Bq) per gram above background level, of settleable solids for beta gamma-emitting radionuclides. | Discharge of radioactive concentrations in sediments to surface water from a DOE facility¾**TBC**. | DOE O 5400.5 II(3)(a)(4) | | | |



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Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | To protect native animal aquatic organisms, the absorbed dose to these organisms shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways. | | DOE O 5400.5 II(3)(a)(5) | | | |
| Technology-based treatment requirements for wastewater discharge | To the extent that EPA promulgated effluent limitations are inapplicable, shall develop on a case-by-case Best Professional Judgment (BPJ) basis under § 402(a)(1)(B) of the CWA, technology based effluent limitations by applying the factors listed in 40 *CFR* § 125.3(d) and shall consider:<br>· The appropriate technology for this category or class of point sources, based upon all available information; and<br>· Any unique factors relating to the discharger. | Discharge of pollutants to surface waters from other than a POTW—**applicable**. | 40 *CFR* § 125.3(c)(2) | | | |
| Water quality-based effluent limits for wastewater discharge | Must develop water quality based effluent limits that ensure that:<br>· The level of water quality to be achieved by limits on point source(s) established under this paragraph is derived from, and complies with all applicable water quality standards; and<br>· Effluent limits developed to protect narrative or numeric water quality criteria are consistent with the assumptions and any available waste load allocation for the discharge prepared by the State and approved by EPA pursuant to 40 *CFR* § 130.7. | Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard established under § 303 of the CWA—**applicable**. | 40 *CFR* § 122.44(d)(1) (vii) | | | |
| | Must attain or maintain a specified water quality through water quality related effluent limits established under § 302 of the CWA. | Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard—**applicable**. | 40 *CFR* § 122.44(d)(2) | | | |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | The numeric water quality criteria for fish consumption specified in Table 1 of 401 *KAR* 10:031 Section 6(1) provides allowable instream concentrations of pollutants that may be found in surface waters or discharged into surface waters. | | 401 *KAR* 10:031 § 6(1) | | | |
| Monitoring requirements for groundwater treatment system discharges | In addition to 40 *CFR* §122.48(a) and (b) and to assure compliance with effluent limitations, one must monitor, as provided in subsections (i) thru (iv) of 122.44(i)(1).<br>*NOTE:* Monitoring parameters, including frequency of sampling, will be developed as part of the CERCLA process and included in a Remedial Design, RAWP, or other appropriate FFA CERCLA document. | Discharge of pollutants to surface waters—**applicable**. | 40 *CFR* § 122.44(i)(1)<br>401 *KAR* § 5:065 2(4) | | | |
| | All effluent limitations, standards and prohibitions shall be established for each outfall or discharge point, except as provided under § 122.44(k). | | 40 *CFR* § 122.45(a)<br>401 *KAR* § 5:065 2(5) | | | |
| | All effluent limitations, standards and prohibitions, including those necessary to achieve water quality standards, shall unless impracticable be stated as:<br>· Maximum daily and average monthly discharge limitations for all discharges. | Continuous discharge of pollutants to surface waters—**applicable**. | 40 *CFR* § 122.45(d)(1)<br>401 *KAR* § 5:065 2(5) | | | |
| Effluent limits for radionuclides in wastewater | Shall not exceed the limits for radionuclides listed on Table II—Effluent Limitations. | Discharge of wastewater with radionuclides from an NRC Agreement State licensed facility into surface waters¾ **relevant and appropriate**. | 902 *KAR* 100:019 § 44 (7)(a) | | | |



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## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| General standards for process vents used in treatment of VOC contaminated groundwater | Select and meet the requirements under one of the options specified below:<br>· Control HAP emissions from the affected process vents according to the applicable standards specified in §§ 63.7890 through 63.7893.<br>· Determine for the remediation material treated or managed by the process vented through the affected process vents that the average total volatile organic hazardous air pollutant (VOHAP) concentration, as defined in § 63.7957, of this material is less than 10 (ppmw). Determination of VOHAP concentration will be made using procedures specified in § 63.7943.<br>· Control HAP emissions from affected process vents subject to another subpart under 40 *CFR* part 61 or 40 *CFR* part 63 in compliance with the standards specified in the applicable subpart. | Process vents as defined in 40 *CFR* § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit hazardous air pollutants (HAP) listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *CFR* §63.7885(c)(1)—**relevant and appropriate**. | 40 *CFR* § 63:7885(b)<br>401 *KAR* 63:002, §§ 1 and 2, except for 40 *CFR* § 63.72 as incorporated in § 2(3) | | | |



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### Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Emission limitations for process vents used in treatment of VOC contaminated groundwater | Meet the requirements under one of the options specified below:<br>· Reduce from all affected process vents the total emissions of the HAP to a level less than 1.4 kilograms per hour (kg/hr) and 2.8 Mg/yr (3.0 pounds per hour (lb/hr) and 3.1 tpy);<br>· Reduce from all affected process vents the emissions of total organic compounds (TOC) (minus methane and ethane) to a level below 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr and 3.1 tpy);<br>· Reduce from all affected process vents the total emissions of the HAP by 95 percent by weight or more; or<br>· Reduce from all affected process vents the emissions of TOC (minus methane and ethane) by 95 percent by weight or more.<br>*NOTE: These emission limits are for the remediation activities conducted at the PGDP by the DOE.* | Process vents as defined in 40 *CFR* § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit hazardous air pollutants (HAP) listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *CFR* § 63.7885(c)(1)—**relevant and appropriate**. | 40 *CFR* § 63.7890(b)(1)-(4)<br>401 *KAR* 63:002, §§ 1 and 2, except for 40 *CFR* § 63.72 as incorporated in § 2(3) | | | |
| Standards for closed vent systems and control devices used in treatment of VOC contaminated groundwater | For each closed vent system and control device you use to comply with the requirements above, you must meet the operating limit requirements and work practice standards in Sec. 63.7925(d) through (j) that apply to the closed vent system and control device.<br>*NOTE:* EPA approval to use alternate work practices under paragraph (j) in 40 *CFR* § 63.7925 will be obtained in FFA CERCLA document (e.g., Remedial Design). | Closed vent system and control devices as defined in 40 *CFR* § 63.7957 that are used to comply with § 63.7890(b)—**relevant and appropriate**. | 40 *CFR* § 63.7890(c) | | | |
| Monitoring of closed vent systems and control devices used in treatment of VOC contaminated groundwater | Must monitor and inspect the closed vent system and control device according to the requirements in 40 *CFR* § 63.7927 that apply to the affected source.<br>*NOTE:* Monitoring program will be developed as part of the CERCLA process and included in a Remedial Design or other appropriate FFA CERCLA document. | Closed vent system and control devices as defined in 40 *CFR* § 63.7957 that are used to comply with § 63.7890(b)—**relevant and appropriate**. | 40 *CFR* § 63.7892 | | | |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Treatment of LLW | Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility. | Treatment of LLW for disposal at a LLW disposal facility—**TBC**. | DOE M 435.1-1(IV)(O) | ü | ü | ü |
| Disposal of prohibited RCRA hazardous waste in a land-based unit | May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* § 268.40 before land disposal. | Land disposal, as defined in 40 *CFR* § 268.2, of prohibited RCRA waste—**applicable**. | 40 *CFR* § 268.40(a)<br>401 *KAR* 37:040 § 2 | ü | ü | ü |
| | All underlying hazardous constituents [as defined in 40 *CFR* § 268.2(i)] must meet the Universal Treatment Standards, found in 40 *CFR* § 268.48 Table UTS prior to land disposal. | Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well—**applicable**. | 40 *CFR* § 268.40(e)<br>401 *KAR* 37:040 § 2 | ü | ü | ü |
| | Must be treated according to the alternative treatment standards of 40 *CFR* § 268.49(c) <u>or</u> according to the UTSs specified in 40 *CFR* § 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal. | Land disposal, as defined in 40 *CFR* § 268.2, of restricted hazardous soils—**applicable**. | 40 *CFR* § 268.49(b)<br>401 *KAR* 37:040 § 10 | ü | ü | ü |
| Disposal of RCRA hazardous debris in a land-based unit | Must be treated prior to land disposal as provided in 40 *CFR* § 268.45(a)(1)-(5) unless EPA determines under 40 *CFR* § 261.3(f)(2) that the debris no longer contaminated with hazardous waste <u>or</u> the debris is treated to the waste-specific treatment standard provided in 40 *CFR* § 268.40 for the waste contaminating the debris. | Land disposal, as defined in 40 *CFR* § 268.2, of RCRA-hazardous debris—**applicable**. | 40 *CFR* § 268.45(a)<br>401 *KAR* 37:040 § 7 | | ü | ü |

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### Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Disposal of RCRA characteristic wastewaters in an NPDES permitted wastewater treatment unit | Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 of the CWA (i.e., NPDES permitted) unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* § 268.40, or are D003 reactive cyanide.<br>NOTE: For purposes of this exclusion, a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a system, is considered a wastewater treatment system that is NPDES permitted. | Land disposal of hazardous wastewaters that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 *CFR* Part 268—**applicable**. | 40 *CFR* § 268.1(c)(4)(i)<br>401 *KAR* 37:010 § 2 | | | |
| Disposal of bulk PCB remediation waste off-site (self-implementing) | May be sent off-site for decontamination or disposal provided the waste either is dewatered on-site or transported off-site in containers meeting the requirements of DOT HMR at 49 *CFR* parts 171-180. | Generation of bulk PCB remediation waste (as defined in 40 *CFR* § 761.3) for off-site disposal—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(i)(B) | ü | ü | ü |
| | Must provide written notice including the quantity to be shipped and highest concentration of PCBs [using extraction EPA Method 3500B/3540C or Method 3500B/3550B followed by chemical analysis using Method 8082 in SW-846 or methods validated under 40 *CFR* § 761.320-26 (Subpart Q)] before the first shipment of waste to each off-site facility where the waste is destined for an area not subject to a TSCA PCB Disposal Approval. | Bulk PCB remediation waste (as defined in 40 *CFR* § 761.3) destined for an off-site facility not subject to a TSCA PCB Disposal Approval—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(i)(B)(2)*(iv)* | ü | ü | ü |
| | Shall be disposed of in accordance with the provisions for cleanup wastes at 40 *CFR* § 761.61(a)(5)(v)(A). | Off-site disposal of dewatered bulk PCB remediation waste with a PCB concentration < 50 ppm—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(i)(B)(2)*(ii)* | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Shall be disposed of<br>· in a hazardous waste landfill permitted by EPA under §3004 of RCRA; | Off-site disposal of dewatered bulk PCB remediation waste with a PCB concentration ≥ 50 ppm—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(i)(B)(2)*(iii)* | ü | ü | ü |
| | · in a hazardous waste landfill permitted by a State authorized under §3006 of RCRA; or | | | ü | ü | ü |
| | · in a PCB disposal facility approved under 40 *CFR* § 761.60. | | | ü | ü | ü |
| Disposal of liquid PCB remediation waste (self-implementing) | Shall either<br>· decontaminate the waste to the levels specified in 40 *CFR* § 761.79(b)(1) or (2); or | Liquid PCB remediation waste (as defined in 40 *CFR* § 761.3)—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(iv)<br>40 *CFR* § 761.61(a)(5)(iv)(A) | ü | ü | ü |
| | · dispose of the waste in accordance with the performance-based requirements of 40 *CFR* § 761.61(b) or in accordance with a risk-based approval under 40 *CFR* § 761.61(c). | | 40 *CFR* § 761.61(a)(5)(iv)(B) | ü | ü | ü |
| Performance-based disposal of PCB remediation waste | May dispose by one of the following methods<br>· in a high-temperature incinerator under 40 *CFR* § 761.70(b); | Disposal of non-liquid PCB remediation waste (as defined in 40 *CFR* § 761.3)—**applicable**. | 40 *CFR* § 761.61(b)(2)<br>40 *CFR* § 761.61(b)(2)(i) | ü | ü | ü |
| | · by an alternate disposal method under 40 *CFR* § 761.60(e); | | | ü | ü | ü |
| | · in a chemical waste landfill under 40 *CFR* § 761.75; | | | ü | ü | ü |
| | · in a facility under 40 *CFR* § 761.77; or | | | ü | ü | ü |
| | · through decontamination in accordance with 40 *CFR* § 761.79. | | 40 *CFR* § 761.61(b)(2)(ii) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | Shall be disposed according to 40 *CFR* § 761.60(a) or (e), or decontaminate in accordance with 40 *CFR* § 761.79. | Disposal of liquid PCB remediation waste—**applicable**. | 40 *CFR* § 761.61(b)(1) | ü | ü | ü |
| Risk-based disposal of PCB remediation waste | May dispose of in a manner other than prescribed in 40 *CFR* § 761.61(a) or (b) if approved in writing from EPA and method will not pose an unreasonable risk of injury to [sic] human health or the environment.<br>*NOTE:* EPA approval of alternative disposal method will be obtained by approval of the FFA CERCLA document. | Disposal of PCB remediation waste—**applicable**. | 40 *CFR* § 761.61(c) | ü | ü | ü |
| Disposal of PCB cleanup wastes (e.g., PPE, rags, non-liquid cleaning materials) (self-implementing option) | Shall be disposed of<br>· in a municipal solid waste facility under 40 *CFR* § 258 or non-municipal, nonhazardous waste subject to 40 *CFR* § 257.5 thru 257.30;<br>· in a RCRA Subtitle C landfill;<br>· in a PCB disposal facility; or<br>· through decontamination under 40 *CFR* § 761.79(b) or (c). | Generation of non-liquid PCBs during and from the cleanup of PCB remediation waste—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(v)(A) | ü | ü | ü |
| Disposal of PCB cleaning solvents, abrasives, and equipment (self-implementing option) | May be reused after decontamination in accordance with 40 *CFR* § 761.79; or<br>For liquids, disposed in accordance with 40 *CFR* § 761.60(a). | Generation of PCB wastes from the cleanup of PCB remediation waste—**relevant and appropriate**. | 40 *CFR* § 761.61(a)(5)(v)(B)<br>40 *CFR* § 761.60(b)(1)(i)(B) | ü | ü | ü |
| Disposal of PCB decontamination waste and residues | Shall be disposed of at their existing PCB concentration unless otherwise specified in 40 *CFR* § 761.79(g)(1) through (6). | PCB decontamination waste and residues for disposal¾ **applicable**. | 40 *CFR* § 761.79(g) | ü | ü | ü |
| Disposal of LLW | LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility. | Disposal of LLW at a LLW disposal facility—**TBC**. | DOE M 435.1-1(IV)(J)(2) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| ***Decontamination/Cleanup*** | | | | | | |
| Decontamination of movable equipment contaminated by PCBs (self-implementing option) | May decontaminate by<br>· swabbing surfaces that have contacted PCBs with a solvent;<br>· a double wash/rinse as defined in 40 *CFR* § 761.360-378; or<br>· another applicable decontamination procedure under 40 *CFR* § 761.79. | Movable equipment contaminated by PCB and tools and sampling equipment—**applicable**. | 40 *CFR* § 761.79(c)(2) | ü | ü | ü |
| Decontamination of PCB containers (self-implementing option) | Must flush the internal surfaces of the container three times with a solvent containing < 50 ppm PCBs. Each rinse shall use a volume of the flushing solvent equal to approximately 10% of the PCB container capacity. | PCB Container as defined in 40 *CFR* § 761.3—**applicable**. | 40 *CFR* § 761.79(c)(1) | ü | ü | ü |
| Decontamination of PCB contaminated water | For discharge to a treatment works as defined in 40 *CFR* § 503.9 (aa), or discharge to navigable waters, meet standard of < 3 ppb PCBs; or | Water containing PCBs regulated for disposal—**applicable**. | 40 *CFR* § 761.79(b)(1)(ii) | ü | ü | ü |
| | The decontamination standard for water containing PCBs is less than or equal to 0.5 µg/L (i.e., approximately ≤0.5 ppb PCBs) for unrestricted use. | | 40 *CFR* § 761.79(b)(1)(iii) | ü | ü | ü |
| ***Unit Closure*** | | | | | | |
| Closure performance standard for RCRA container storage unit | Must close the facility (e.g., container storage unit) in a manner that:<br>· Minimizes the need for further maintenance;<br>· Controls minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and<br>· Complies with the closure requirements of this subpart, but not limited to, the requirements of 40 *CFR* § 264.178 for containers. | Storage of RCRA hazardous waste in containers¾ **applicable**. | 40 *CFR* § 264.111<br>401 *KAR* 34:070 § 2 | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Closure of RCRA container storage unit | At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed.<br>[Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 *CFR* § 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter.] | Storage of RCRA hazardous waste in containers in a unit with a containment system¾ **applicable**. | 40 *CFR* § 264.178<br>401 *KAR* 34:180 § 9 | ü | ü | ü |
| Clean closure of TSCA storage facility | A TSCA/RCRA storage facility closed under RCRA is exempt from the TSCA closure requirements of 40 *CFR* § 761.65(e). | Closure of TSCA/RCRA storage facility—**applicable**. | 40 *CFR* § 761.65(e)(3) | ü | ü | ü |
| | | ***Waste transportation*** | | | | |
| Transportation of samples (i.e., contaminated soils and wastewaters) | Are not subject to any requirements of 40 *CFR* Parts 261 through 268 or 270 when:<br>· The sample is being transported to a laboratory for the purpose of testing; or<br>· The sample is being transported back to the sample collector after testing. | Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition¾ **applicable**. | 40 *CFR* § 261.4(d)(1)(i) and (ii) | ü | ü | ü |

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## Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| | In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must:<br>· Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements.<br>· Assure that the information provided in (1) thru (5) of this section accompanies the sample.<br>· Package the sample so that it does not leak, spill, or vaporize from its packaging. | | 40 *CFR* § 261.4(d)(2)(i)<br>40 *CFR* § 261.4(d)(2)(i)(A)<br>40 *CFR* § 261.4(d)(2)(i)(B) | ü | ü | ü |
| Transportation of RCRA hazardous waste on-site | The generator manifesting requirements of 40 *CFR* §§ 262.20- 262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* § 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way. | Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**. | 40 *CFR* § 262.20(f)<br>401 *KAR* 32:020 § 1 | ü | ü | ü |
| Transportation of RCRA hazardous waste off-site | Must comply with the generator requirements of 40 *CFR* § 262.20- 23 for manifesting, § 262.30 for packaging, § 262.31 for labeling, § 262.32 for marking, § 262.33 for placarding, § 262.40, 262.41(a) for record keeping requirements, and § 262.12 to obtain EPA ID number. | Preparation and initiation of shipment of hazardous waste off-site—**applicable**. | 40 *CFR* § 262.10(h)<br>401 *KAR* 32:010 § 1 | ü | ü | ü |
| Transportation of PCB wastes off-site | Must comply with the manifesting provisions at 40 *CFR* § 761.207 through 218. | Relinquishment of control over PCB wastes by transporting, or offering for transport—**applicable**. | 40 *CFR* § 761.207(a) | ü | ü | ü |



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**Table A.2. Action-specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites (Continued)**

| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Determination of radionuclide concentration | The concentration of a radionuclide may be determined by an indirect method, such as use of a scaling factor which relates the inferred concentration of one (1) radionuclide to another that is measured or radionuclide material accountability if there is reasonable assurance that an indirect method may be correlated with an actual measurement.<br>The concentration of a radionuclide may be averaged over the volume or weight of the waste if the units are expressed as nanocuries per gram. | Preparation for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility¾ **relevant and appropriate**. | 10 *CFR* § 61.55 (a)(8)<br>902 *KAR* 100:021 § 6(8)(a) and (b) | ü | ü | ü |
| Labeling of LLW packages | Each package of waste shall be clearly labeled to identify if it is Class A, Class B, or Class C waste, in accordance with 10 *CFR* § 61.55 or Agreement State waste classification requirements. | Preparation for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility¾ **relevant and appropriate**. | 10 *CFR* § 61.57<br>902 *KAR* 100:021 § 8 | ü | ü | ü |
| Transportation of radioactive waste | Shall be packaged and transported in accordance with DOE Order 460.1B and DOE Order 460.2. | Preparation of shipments of radioactive waste—**TBC**. | DOE M 435.1-(I)(1)(E)(11) | ü | ü | ü |
| Transportation of LLW | To the extent practicable, the volume of the waste and the number of the shipments shall be minimized. | Preparation of shipments of LLW—**TBC**. | DOE M 435.1-1(IV)(L)(2) | ü | ü | ü |
| Transportation of hazardous materials | Shall be subject to and must comply with all applicable provisions of the HMR at 49 *CFR* §§ 171- 180 related to marking, labeling, placarding, packaging, emergency response, etc. | Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material—**applicable**. | 49 *CFR* § 171.1(c) | ü | ü | ü |

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| Action | Requirement | Prerequisite | Citation | Alt 2 | Alt 3 | Alt 8 |
|---|---|---|---|---|---|---|
| Transportation of hazardous materials on-site | Shall comply with 49 *CFR* Parts 171-174, 177, and 178 or the site- or facility-specific Operations of Field Office approved Transportation Safety Document that describes the methodology and compliance process to meet equivalent safety for any deviation from the Hazardous material Regulations (i.e., *Transportation Safety Document for On-Site Transport within the Paducah Gaseous Diffusion Plant*, PAD-WD-0661). | Any person who, under contract with the DOE, transports a hazardous material on the DOE facility—**TBC**. | DOE O 460.1B(4)(b) | ü | ü | ü |
| Transportation of hazardous materials off-site | Off-site hazardous materials packaging and transfers shall comply with 49 *CFR* Parts 171-174, 177, and 178 and applicable tribal, State, and local regulations not otherwise preempted by DOT and special requirements for Radioactive Material Packaging. | Preparation of off-site transfers of LLW¾**TBC**. | DOE O 460.1B(4)(a) | ü | ü | ü |

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
BMP = best management practices
BPJ = best professional judgment
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
*CFR* = *Code of Federal Regulations*
CWA = Clean Water Act
DOE = U.S. Department of Energy
DOE O = DOE Order
DOE M = DOE Manual
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
EPA = U.S. Environmental Protection Agency
E.O. = Executive Order
HAP = hazardous air pollutant
HMR = hazardous material regulations
*KAR* = *Kentucky Administrative Regulations*
KPDES = Kentucky Pollutant Discharge Elimination System
LLW = low-level waste
NPDES = Pollutant Discharge Elimination System
NRC = Nuclear Regulatory Commission
NWP = Nationwide Permit
PCB = polychlorinated biphenyl
PGDP = Paducah Gaseous Diffusion Plant
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act
ROD = Record of Decision
TBC = to be considered
TSCA = Toxic Substances Control Act
UTS = Universal Treatment Standards
VOC = volatile organic compounds
VOHAP = volatile organic hazardous air pollutant
WAC = waste acceptance criteria



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