DOE/LX/07-0012&D2
Primary Document

Engineering Evaluation/Cost Analysis for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

CLEARED FOR PUBLIC RELEASE

DOE/LX/07-0012&D2
Primary Document

Engineering Evaluation/Cost Analysis for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—August 2008

Revised Date—September 2008

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

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06EW05001

THIS PAGE INTENTIONALLY LEFT BLANK

PREFACE

This *Engineering Evaluation/Cost Analysis for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (EE/CA), DOE/LX/07-0012&D2, was prepared to evaluate removal action alternatives associated with the Surface Water Operable Unit (SWOU) (On-Site) in compliance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act. The SWOU (On-Site) EE/CA includes the Paducah Gaseous Diffusion Plant (PGDP) Outfalls 001 (those portions not addressed by the Scrap Metal Basin), 008, 010, 011, and 015, and their associated internal ditches and areas [including Solid Waste Management Unit (SWMU) 92 and SWMU 97]; and North-South Diversion Ditch (NSDD) Sections 3, 4, and 5. The results of the SWOU (On-Site) Site Investigation (DOE 2006) determined that there were no unacceptable levels of risk to current and anticipated future receptors that warranted inclusion of Outfall 002, Outfall 012, or the PGDP storm sewer systems associated with C-333-A, C-337-A, C-340, C-535, and C-537 within the EE/CA. The alternatives considered contamination areas or hot spots within specific areas or defined exposure units (EUs) located within PGDP Outfalls 001, 008, 010, 011, and 015, and their associated internal ditches and specific areas or EUs located within the NSDD Sections 3, 4, and 5. The objectives of this report are to (1) describe the environmental conditions supporting the need for a removal action, (2) develop and evaluate alternatives, and (3) recommend the alternative that best meets the removal action objectives. This document provides the basis for development of the Action Memorandum to be issued after receipt and consideration of public comments on the EE/CA.

THIS PAGE INTENTIONALLY LEFT BLANK

CONTENTS

FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

ACRONYMS

ABS	dermal absorption factors
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
BERA	Baseline Ecological Risk Assessment
BaP	benzo (a) pyrene
BaPE	BaP equivalent
BHHRA	Baseline Human Health Risk Assessment
BJC	Bechtel Jacobs Company LLC
BMP	best management practice
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
COPC	chemical of potential concern
CSOU	Comprehensive Site Operable Unit
dbh	diameter at breast height
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EE/CA	Engineering Evaluation/Cost Analysis
ELCR	excess lifetime cancer risk
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentrations
ERA	Ecological Risk Assessment
EU	exposure unit
FFA	Federal Facility Agreement
FR	*Federal Register*
GI	gastrointestinal
HDPE	high-density polyethylene
HI	hazard index
ICM	Interim Corrective Measure
IRA	interim remedial action
KAR	*Kentucky Administrative Record*
KDEP	Kentucky Department for Environmental Protection
KDFWR	Kentucky Department of Fish and Wildlife Resources
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
LMES	Lockheed Martin Energy Systems, Inc.
MUSLE	Modified Universal Soil Loss Equation
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NWP	Nationwide Permit
O&M	Operation and Maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbon

PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
PRS	Paducah Remediation Services, LLC
PVC	polyvinyl chloride
RAO	Removal Action Objective
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity
RfD	oral reference dose
RGA	Regional Gravel Aquifer
RGO	removal goal option
RI	Remedial Investigation
ROD	Record of Decision
SADA	Spatial Analysis and Decision Assistance
SAP	Sampling and Analysis Plan
SERA	Screening Ecological Risk Assessment
SI	Site Investigation
SMP	Site Management Plan
SWMM	Storm Water Management Model
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
T&E	threatened and endangered
TBC	to be considered
TCE	trichloroethene
TSCA	Toxic Substances Control Act of 1976
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USEC	United States Enrichment Corporation
USFWS	U.S. Fish and Wildlife Service
WAG	Waste Area Group
WKWMA	West Kentucky Wildlife Management Area
WQC	water quality criteria

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). PGDP is located in western Kentucky, approximately 10 miles west of Paducah, Kentucky.

The Surface Water Operable Unit (SWOU) (On-Site) Engineering Evaluation/Cost Analysis (EE/CA) scope includes evaluating specific areas or defined exposure units (EUs)[1] located within PGDP Outfalls 001, 008, 010, 011, and 015, and their associated internal ditches and specific areas or EUs located within the North-South Diversion Ditch (NSDD) Sections 3, 4, and 5. Based upon historical data and the more recent data collected during the SWOU (On-Site) Site Investigation (SI) (DOE 2006), it was determined that there were no unacceptable levels of risk to current and anticipated future receptors that warranted inclusion of Outfall 002, Outfall 012, or the PGDP storm sewer systems associated with C-333-A, C-337-A, C-340, C-535, and C-537 in this EE/CA.

As described in the SWOU (On-Site) SI, the following are the Remedial Action Objectives that have been established for the SWOU (On-Site).

- Control sources early; focus resources at areas that warrant attention in the near term, prioritizing actions within areas to address the greatest risks first.
- Minimize human exposure to contaminants, maximizing the effectiveness of institutional controls.
- Control further migration of contaminated sediment.[2]
- Reduce risk from contaminated sediment hot spots.
- Reduce the risk, making progress toward the ultimate goal of protecting recreational users and industrial workers from exposure to contaminated surface water and sediment.

The Removal Action Objectives (RAOs) specific for this removal action are consistent with the overall Remedial Action Objectives for the SWOU (On-Site) and are as follows:

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

Based on evaluations of the effectiveness, implementability, and cost of each proposed alternative, the preferred alternative identified for this removal action is Alternative 4 – "Excavation and Interim Institutional Controls." This alternative meets all the RAOs for the removal action, is effective, can be implemented, and is the most cost-effective option that meets the specified requirements. Cost of

[1] An EU is defined as approximately 0.5 acres. This is consistent with the EU size used for Sections 1 and 2 of the NSDD (DOE 2002a), the EU size used for the Surface Water Operable Unit (On-Site) SI (DOE 2006), and the EU size for industrial areas specified in the PGDP Risk Methods Document (DOE 2001).

[2] The SWOU SI determined that migration does not need to be addressed by this EE/CA; however, addressing of hot spots associated with on-site exposure will reduce the potential risks associated with any off-site migration.

implementation of Alternative 4 is estimated to have a present value of $7.7M and an escalated value of $8.3M over a 30-year design life.

1. INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) documents and describes the evaluation of alternatives to address the threat to human health and the environment resulting from the release or potential release of hazardous materials associated with contamination from Sections 3, 4, and 5 of the North-South Diversion Ditch (NSDD) and Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls 001, 008, 010, 011, and 015 at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky.

The NSDD and outfalls receive surface water runoff and wastewater from various sources within PGDP. Waste water discharged to outfalls is regulated by KPDES Permits. The storm sewer system at PGDP has been in operation since 1951 and continues to receive drainage from the plant. This document was prepared in accordance with the U.S. Environmental Protection Agency's (EPA's) *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993).

1.1 SITE DESCRIPTION AND BACKGROUND

PGDP is located approximately 10 miles west of Paducah, Kentucky (population approximately 26,000), and 3.5 miles south of the Ohio River in the western part of McCracken County (Figure 1). The plant is on a 3,556-acre U.S. Department of Energy (DOE) site, 748 acres of which are within a fenced security area, 822 acres are located outside the security fence (133 acres are in acquired easements), and the remaining 1,986 acres are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA). Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which the Shawnee Steam Plant is located (Figure 2).

Before the PGDP was built, a munitions-production facility, the Kentucky Ordnance Works (KOW), was operated at the current PGDP location and at an adjoining area southwest of the site. Munitions, including trinitrotoluene, were manufactured and stored at the KOW between 1942 and 1945. The KOW was shut down immediately after World War II. Construction of PGDP was initiated in 1951 and the plant began operations in 1952. Construction was completed in 1955 and PGDP became fully operational in 1955, supplying enriched uranium for commercial reactors and military defense reactors.

PGDP was operated by Union Carbide Corporation until 1984, when Martin Marietta Energy Systems, Inc. [which later became Lockheed Martin Energy Systems, Inc. (LMES)], was contracted to operate the plant for DOE. On July 1, 1993, DOE leased the plant production/operations facilities to the United States Enrichment Corporation (USEC); however, DOE maintains ownership of the plant and is responsible for environmental restoration and waste management activities. On April 1, 1998, Bechtel Jacobs Company LLC, (BJC) replaced LMES in implementing the Environmental Management (EM) Program at PGDP. On April 23, 2006, Paducah Remediation Services, LLC, (PRS) replaced BJC in implementing the EM Program at PGDP.

PGDP was placed on the National Priorities List (NPL), effective June 30, 1994 (59 *Federal Register* 27989, May 31, 1994). A Federal Facility Agreement (FFA) negotiated among DOE, EPA, and the Commonwealth of Kentucky coordinates the requirements of both the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the facility.

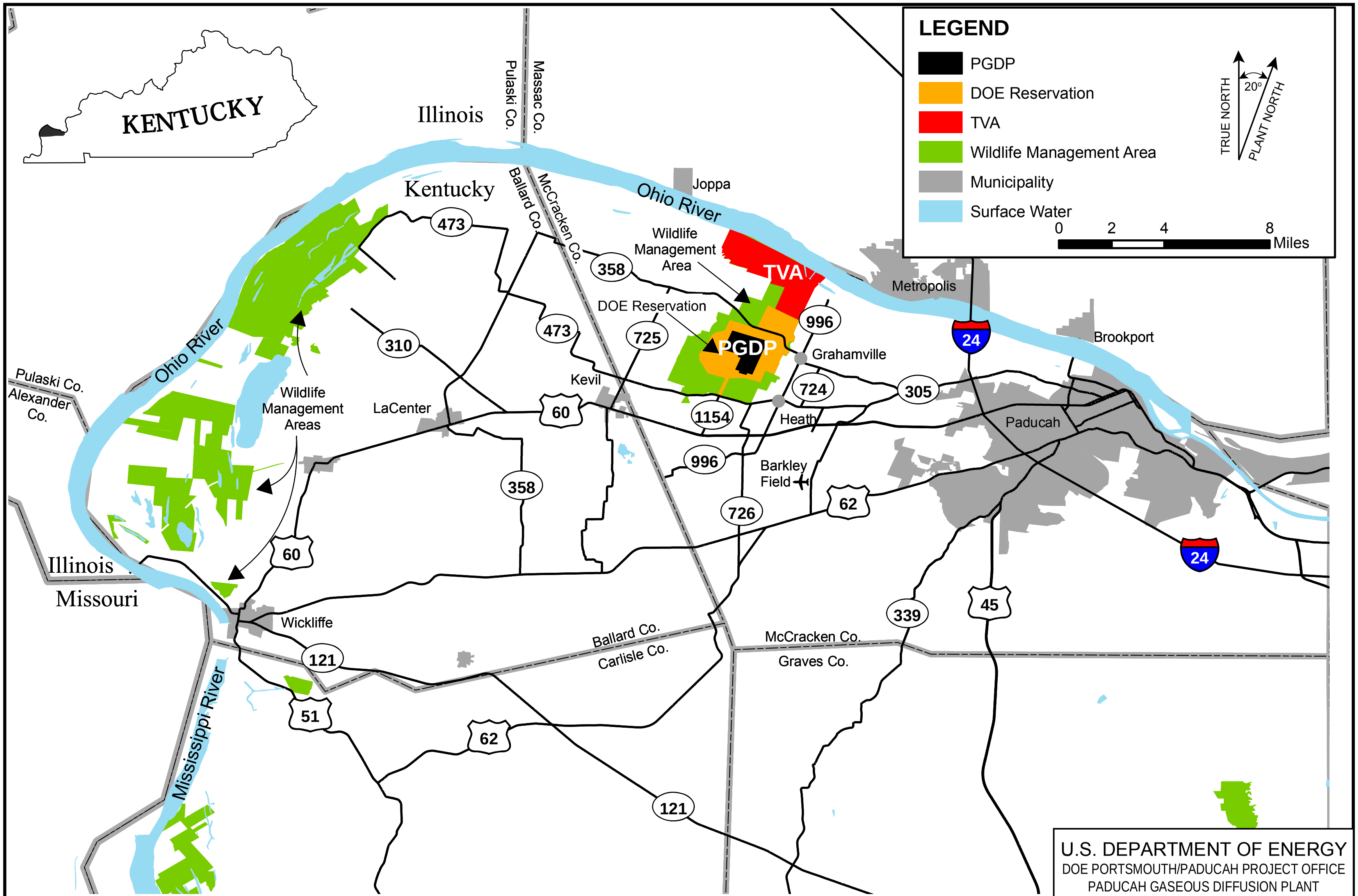
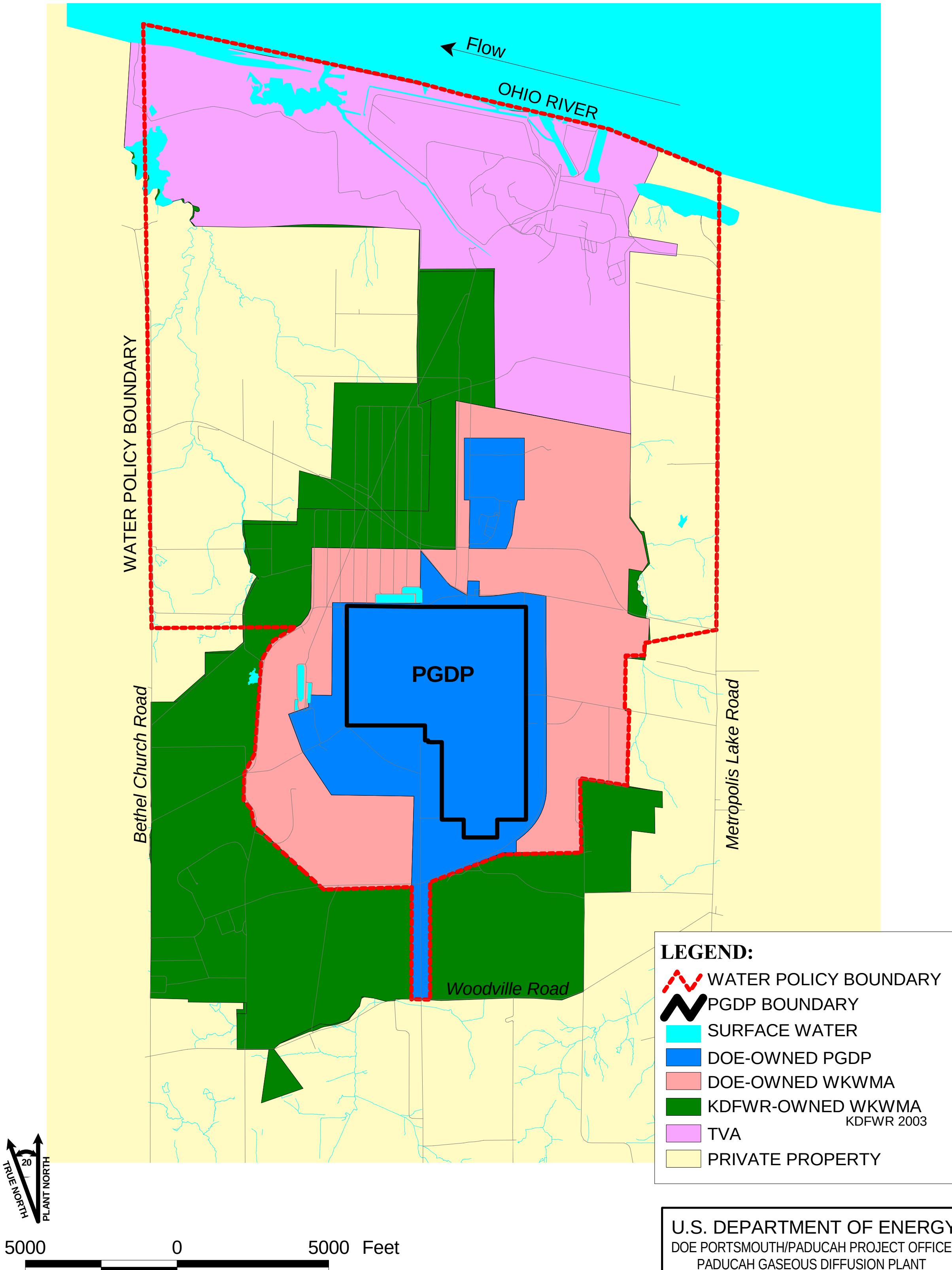


Figure 1. PGDP Site Location



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

Figure 2. PGDP Land Ownership Map

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. C5AC90005sk003.apr
DATE 08-23-06

DOE has undertaken projects to identify, investigate, and remediate, as necessary, all solid waste management units (SWMUs) and areas of concern at PGDP. To facilitate the remediation process at PGDP and focus investigations on the most effective and efficient remedial actions, operable units (OUs) have been defined. These OUs consist of both source control units (i.e., units that may contribute contamination to other units) and integrator units (i.e., units that "collect" contamination from source control units). Six OUs have been defined at PGDP: groundwater, surface water, soil, burial grounds, decontamination and decommissioning (D&D), and comprehensive sitewide. This removal action is included as part of the Surface Water OU (SWOU).

1.1.1 Regional Topography

PGDP lies in the Jackson Purchase Region of western Kentucky between the Tennessee and Mississippi Rivers, bounded on the north by the Ohio River. The confluence of the Ohio and Mississippi Rivers is approximately 56 km (35 miles) downstream (southwest) from the site. The confluence of the Ohio and Tennessee Rivers is approximately 24.14 km (15 miles) upstream (east) from the site.

Local elevations range from 88.41 m (290 ft) above mean sea level (amsl) along the Ohio River to 137.2 m (450 ft) amsl in the southwestern portion of PGDP near Bethel Church Road. Generally, the topography in the PGDP area slopes toward the Ohio River at an approximate 5.11 m/km (27 ft/mile) gradient (CH2M HILL 1992). Within the plant boundaries, ground surface elevations vary from 109.75 m (360 ft) to 118.9 m (390 ft) amsl. The terrain in the vicinity of the plant is slightly modified by the dendritic drainage systems associated with the two principal streams in the area, Bayou Creek and Little Bayou Creek. These streams have small valleys, which are about 6.09 m (20 ft) below the adjacent plain. These small valleys are the result of construction of plant drainage systems in the early 1950s, natural erosion, and/or maintenance.

The average pool elevation of the Ohio River is 88.41 m (290 ft) amsl, and the high water elevation is 104.26 m (342 ft) amsl (TCT-St. Louis 1991). Approximately 100 small lakes and ponds exist on DOE property (TCT-St. Louis 1991). A marsh covering 66.8 hectares (ha) (165 acres) exists off-site of DOE property, immediately south of the confluence of Bayou Creek and Little Bayou Creek (TCT-St. Louis 1991).

1.1.2 Land Use and Population

The PGDP is heavily industrialized; however, the area surrounding the plant is mostly agricultural and open land, with some forested areas. TVA's Shawnee Steam Plant, adjacent to the northeast border of the DOE Reservation, is the only other major industrial facility in the immediate area. The Honeywell Plant (formerly Allied Signal) north of the Ohio River near Metropolis, Illinois, produces feed material for PGDP.

The PGDP site includes 804 ha (1,986 acres) licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources (KDFWR). This area is part of the WKWMA and borders PGDP to the north, west, and south. The WKWMA is an important recreational resource for western Kentucky and is used by more than 10,000 people each year. Major recreational activities include hunting, field trials for dogs and horses, trail riding, fishing, and skeet shooting.

Total population within an 80.46 km (50-mile) radius of PGDP is approximately 500,000. Approximately 50,000 people live within 16.09 km (10 miles) of PGDP and homes are scattered along rural roads around the plant. The population of Paducah, based on the 2000 U.S. Census, is 26,307; the total population of McCracken County [650.4 km^2 (251 mi^2)] is approximately 65,000. The closest communities to PGDP are the unincorporated towns of Grahamville [about 1.6 km (1 mile) to the east] and Heath [about 1.6 km (1 mile) southeast].

1.1.3 Climate

The climate of the region may be broadly classified as humid-continental. The term “humid” refers to the surplus of precipitation versus evapotranspiration that normally is experienced throughout the year. The “continental” nature of the local climate refers to the dominating influence of the North American landmass. Continental climates typically experience large temperature changes between seasons.

Current and historical meteorological information regarding temperature, precipitation, and wind speed/direction was obtained from the National Oceanic and Atmospheric Administration’s National Climatic Data Center. Additional data were obtained from the National Weather Service office at Barkley Regional Airport.

The mean annual temperature for the Paducah area for 2005 was 58.6 °F. The 22-year average monthly temperature is 58.0°F, with the coldest month being January with an average temperature of 35.1 °F and the warmest month being July with an average temperature of 79.2 °F.

The 22-year average monthly precipitation is 10.16 cm (4.00 in.), varying from an average of 6.93 cm (2.73 in.) in August (the monthly average low) to an average of 11.63 cm (4.58 in.) in April (the monthly average high). The total precipitation for 2005 was 95.12 cm (37.45 in.), compared to the normal of 125.07 cm (49.24 in.).

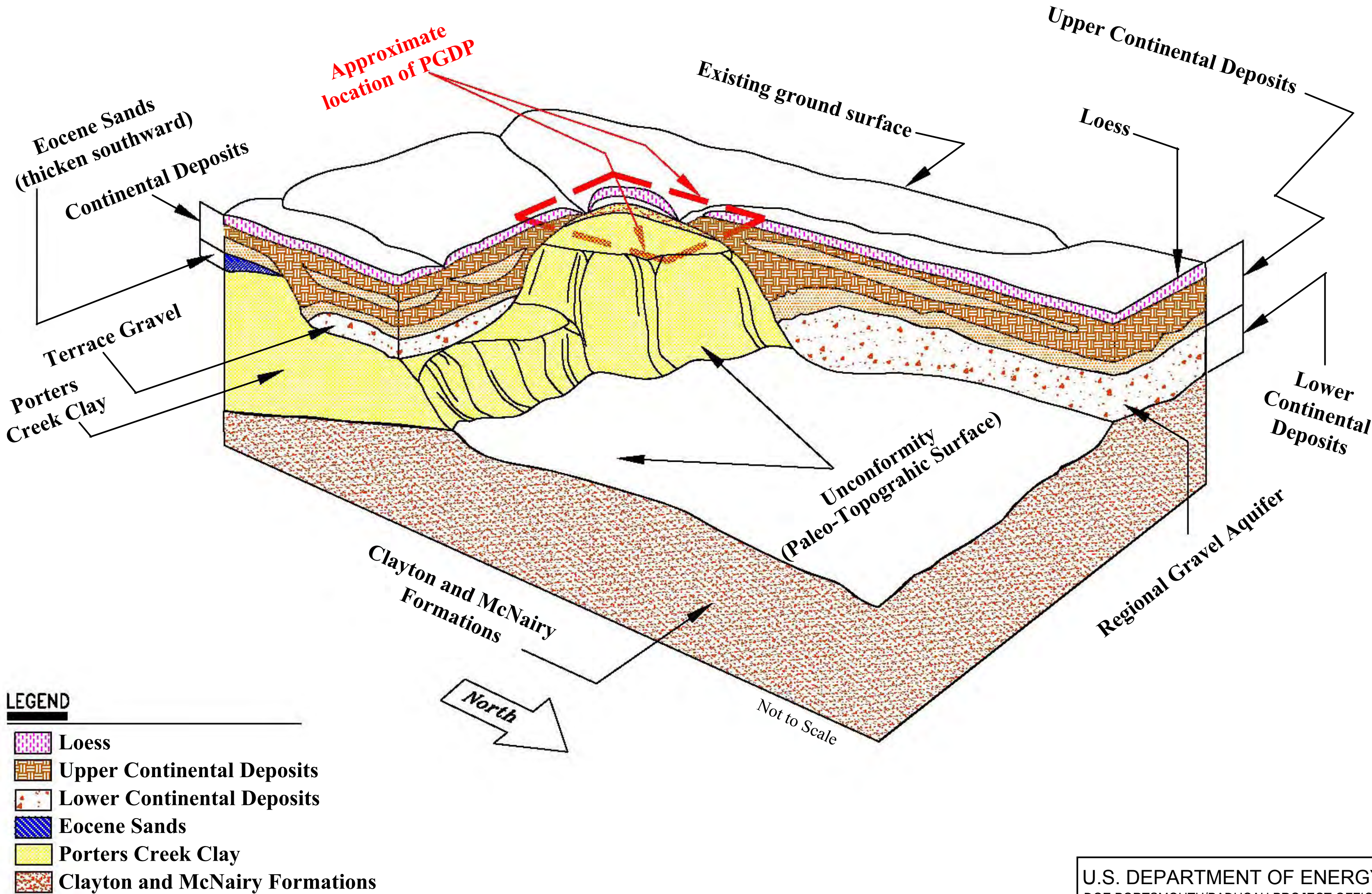
The average mean prevailing wind speed during 2005 was 6.2 mph from the south-southwest. Historically, stronger winds are recorded when the winds are from the southwest.

1.1.4 Geology

PGDP is located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. A generalized geologic cross-section for the PGDP site is presented in Figure 3.

Within the Jackson Purchase Region, strata deposited above the Precambrian basement rock attain a maximum thickness of 3,659 m to 4,573 m (12,000 ft to 15,000 ft). Exposed strata in the region range in age from Devonian to Holocene. The Devonian stratum crops out along the western shore of Kentucky Lake. Mississippian carbonates form the nearest outcrop of bedrock and are exposed approximately 14.5 km (9 miles) northwest of PGDP in southern Illinois (Clausen et al. 1992). The Coastal Plain deposits unconformably overlie Mississippian carbonate bedrock and consist of the following: the Tuscaloosa Formation; the sand and clays of the Clayton/McNairy Formations; the Porters Creek Clay; and the Eocene sand and clay deposits (undivided Jackson, Claiborne, and Wilcox Formations). Continental deposits unconformably overlie the Coastal Plain deposits, which are, in turn, covered by loess and/or alluvium.

Relative to the shallow groundwater flow system in the vicinity of the PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP, marks the southern extent of the buried river valley. Fine sand and clay of the McNairy Formation directly underlie the continental deposits. These continental deposits are continuous from beneath the PGDP to beyond the present course of the Ohio River.



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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure 3. Conceptual Model of the Stratigraphy in the Vicinity of PGDP

The general soil map for Ballard and McCracken counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained to poorly drained, medium-textured soils on upland positions. Several other soil groups also occur in limited areas of the region, including the Grenada, Falaya-Collins, Waverly, Vicksburg, and Loring.

Although the soil over most of PGDP may be Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 45 years. Activities that have disrupted the original soil classifications include filling, mixing, and grading.

1.1.5 Hydrogeology

1.1.5.1 Surface Water

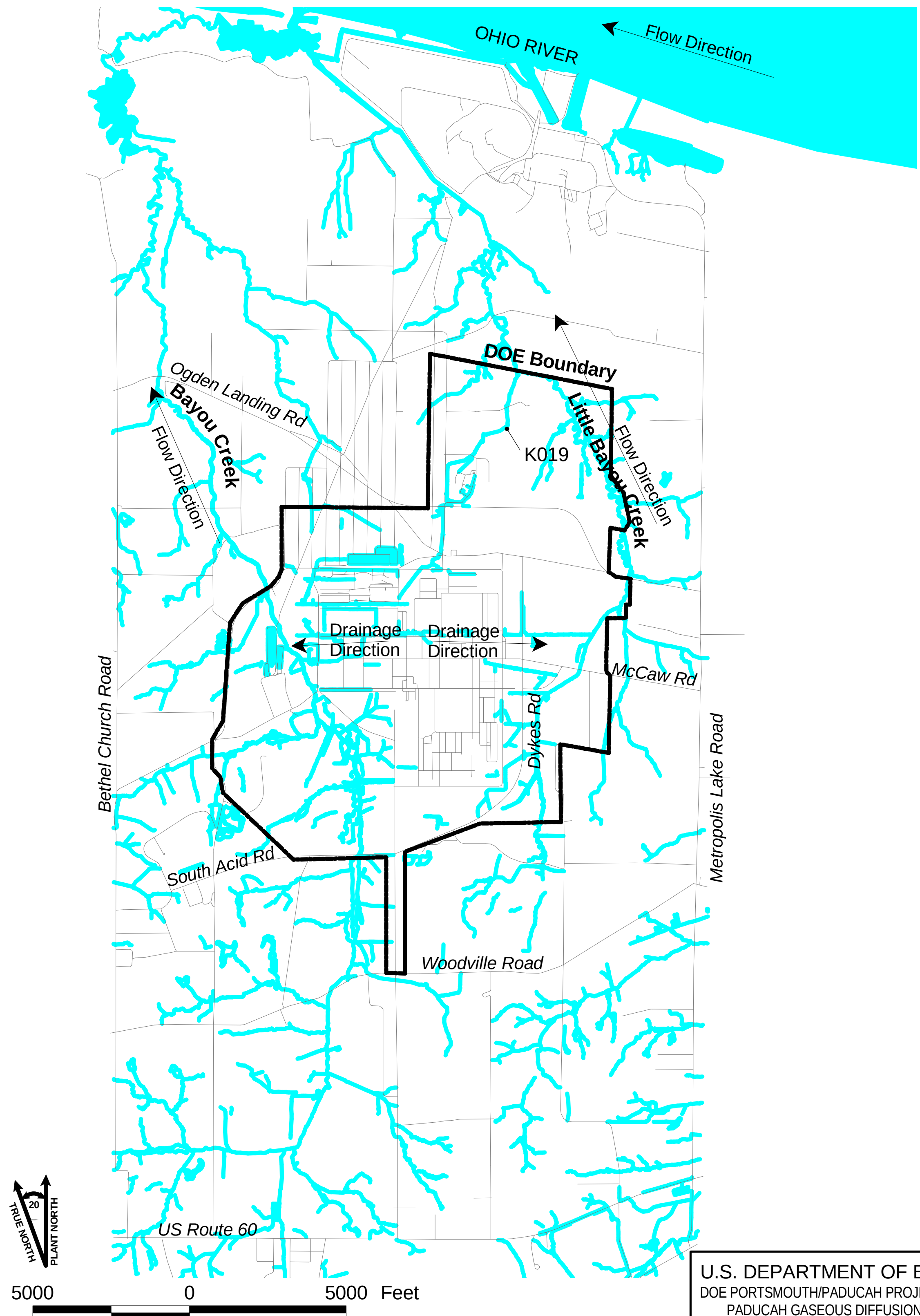
PGDP is located in the western portion of the Ohio River drainage basin, approximately 24 km (15 miles) downstream of the confluence of the Ohio River with the Tennessee River and approximately 56 km (35 miles) upstream of the confluence of the Ohio River with the Mississippi River. Locally, the PDGP is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek), and Little Bayou Creek.[3] Multiple groundwater aquifers underlie PGDP. The shallowest aquifers occur in the Continental Deposits and the McNairy Formation, both of which discharge into the Ohio River north of PGDP. Surface water/groundwater relationships vary significantly across the SWOU.

A shallow water table aquifer, with discharge to the area creeks, occurs to the south of PGDP.[4] Under most of PGDP and the adjacent area to the north, large, downward, vertical hydraulic gradients dominate within the shallow groundwater system, and groundwater infiltrates downward to the Regional Gravel Aquifer (RGA) at a depth of approximately 60 ft (see Section 3.6), limiting the amount of groundwater discharge to the ditches of the PGDP and adjacent creeks. During periods of sustained rainfall, infiltrating water accumulates in the shallow soils and develops an increased throughflow system that discharges infiltrating water temporarily to plant ditches and the area creeks. In the vicinity of the Ohio River, where the land surface is approximately 60 ft lower than at PGDP, Bayou and Little Bayou Creeks cut down to near the potentiometric surface of the RGA. In this area, horizontal groundwater gradients predominate within the water table flow system. Gaining reaches in the creeks are found on Bayou Creek south of PGDP and on both creeks north of PGDP near the Ohio River. While there are no springs near PGDP, seeps are present over a limited stretch of Little Bayou Creek near the Ohio River where hydraulic potential within the RGA exceeds the elevation of the creek. *Surface Water to Groundwater Interaction at the Paducah Gaseous Diffusion Plant* (PRS 2007) discusses the conceptual model for surface water/groundwater interactions at PGDP.

The plant is situated on the divide between the two creeks (Figure 4). Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River along a 14.5-km (9-mile) course. A 4,820-ha (11,910-acre) drainage

[3] Use designations described in 401 *KAR* 5:026 for Bayou Creek and Little Bayou Creek are warm water aquatic habitat (WAH), primary contact recreation (PCR), secondary contact recreation (SCR), and domestic water supply (DWS) at Cairo, Illinois, which is the location of the nearest downstream public water supply (401 *KAR* 5:031).

[4] This water table aquifer exists where the top of the Porters Creek Clay occurs near land surface. The water table aquifer is part of the Terrace Gravel flow system (see Section 1.1.4.2). The Porters Creek Clay is absent under most of PGDP and the adjacent area to the north.



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

Figure 4. Surface Water Features in the Vicinity of the DOE Site

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. C5AC90005sk004.apr
DATE 08-08-06

basin supplies Bayou Creek. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near to the Ohio River along a 10.5-km (6.5-mile) course within a 2,400-ha (6,000-acre) drainage basin. Drainage areas for both creeks are generally rural; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and the TVA Shawnee Steam Plant. The confluence of the two creeks is approximately 4.8 km (3 miles) north of the plant site, just upstream of the location at which the combined flow of the creeks discharge into the Ohio River.

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from PGDP. A network of ditches discharge effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the KPDES outfalls prior to discharge into the creeks. These creeks are monitored at KPDES outfalls for possible contaminant releases from the plant. Outfalls 002, 010, 011, 012, 013, and 018 receive water from the eastern-most portion of the plant and discharge to Little Bayou Creek. Water from the western portion of the plant drains to Bayou Creek through Outfalls 001, 006, 008, 009, 014, 015, 016, and 017. Outfall 004 receives waste water from the C-615 Sewage Treatment Facility and combines with the effluents that lead to Outfall 008. Outfall 019 receives runoff from the C-746-U Landfill located north of PGDP and discharges to the NSDD (Section 4), which flows to Little Bayou Creek. Outfalls 003, 005, and 007 no longer are permitted or discharging.

1.1.5.2 Groundwater

The discussion is intended to provide the reader with a general overview of the groundwater flow regime for PGDP. The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene terrace gravels, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. Four specific components have been identified for the groundwater flow system and are defined in the following paragraphs.

(1) **McNairy Flow System.** Formerly called the deep groundwater system, this component consists of the interbedded and interlensing sand, silt, and clay of the Cretaceous McNairy Formation. Sand facies account for 40–50% of the total formation's thickness of approximately 68.6 m (225 ft). Groundwater flow is predominantly north.

(2) **Terrace Gravel.** This component consists of Pliocene (?)-aged gravel deposits (a question mark indicates uncertain age) and later reworked sand and gravel deposits found at elevations higher than 97.5 m (320 ft) amsl in the southern portion of the plant site; they overlie the Paleocene Porters Creek Clay and Eocene sands. These deposits usually lack sufficient thickness and saturation to constitute an aquifer.

(3) **RGA.** This component consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits are commonly thicker than the Pliocene (?) gravel deposits, having an average thickness of 9.1 m (30 ft), and range up to 15.24 m (50 ft) along an axis that trends east–-west through the plant site. The RGA is the primary local aquifer. Groundwater flow is predominantly north toward the Ohio River.

(4) **Upper Continental Recharge System (UCRS).** Formerly called the shallow groundwater system, this component consists of the surficial alluvium and upper continental deposits. Sand and gravel lithofacies appear relatively discontinuous in cross-section, but portions may be interconnected. The most prevalent sand and gravel deposits occur at an elevation of approximately 105.2 to 106.9 m (345 to 351 ft) amsl; less prevalent deposits occur at elevations of 102.7 to 103.9 m (337 to 341 ft)

amsl. Groundwater flow is predominantly downward into the RGA from the UCRS, which has a limited horizontal component in the vicinity of PGDP.

1.1.6 Ecology

The following sections give a brief overview of the terrestrial and aquatic systems at PGDP. A more detailed description, including an identification and discussion of sensitive habitats and threatened and endangered (T&E) species, is contained in the *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CDM 1994) and *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky* (COE 1994a).

1.1.6.1 Terrestrial Systems

The terrestrial component of the PGDP ecosystem includes the plants and animals that use the upland habitats for food, reproduction, and protection. The upland vegetative communities consist primarily of grassland, forest, and thicket habitats with agricultural areas. The main crops grown in the PGDP area include soybeans, corn, tobacco, and sorghum.

Most of PGDP has been cleared of vegetation at some time, and much of the grassland habitat currently is mowed by PGDP personnel. A large percentage of the adjacent WKWMA is managed to promote native prairie vegetation by burning, mowing, and various other techniques. These areas have the greatest potential for restoration and for establishment of a sizeable prairie preserve in the Jackson Purchase area (KSNPC 1991).

Canopy species of the forested areas include oaks, hickories, maples, elms, and sweetgum. Understory species include snowberry, poison ivy, trumpet creeper, Virginia creeper, and Solomon’s seal.

Thicket areas consist predominantly of maples, black locust, sumac, persimmon, and forest species in the sapling stage with herbaceous ground cover similar to that of the forest understory.

Wildlife commonly found in the PGDP area consists of species indigenous to open grassland, thicket, and forest habitats. The species documented to occur in the area are discussed in the following paragraphs.

Small mammal surveys conducted on WKWMA documented the presence of southern short-tailed shrew, prairie vole, house mouse, rice rat, and deer mouse (KSNPC 1991). Large mammals commonly present in the area include coyote, eastern cottontail, opossum, groundhog, whitetail deer, raccoon, and gray squirrel.

Typical birds of the area include European starling, cardinal, red-winged blackbird, mourning dove, bobwhite quail, turkey, killdeer, American robin, eastern meadowlark, eastern bluebird, bluejay, red-tail hawk, and great horned owl.

Amphibians and reptiles present include cricket frog, Fowler’s toad, common snapping turtle, green tree frog, chorus frog, southern leopard frog, eastern fence lizard, and red-eared slider (KSNPC 1991).

Mist netting activities in the area have captured red bat, little brown bat, Indiana bat, northern long-eared bat, evening bat, and eastern pipistrelle (KSNPC 1991).

1.1.6.2 Aquatic Systems

The aquatic communities in and around the PGDP area that could be impacted by plant discharges include two perennial streams (Bayou Creek and Little Bayou Creek), the NSDD, a marsh located at the confluence of Bayou Creek and Little Bayou Creek, and other smaller drainage areas. The dominant taxa in all surface waters include several species of sunfish, especially bluegill and green sunfish, as well as bass and catfish. Shallow streams, characteristic of the two main area creeks, are dominated by bluegill, green and longear sunfish, and stonerollers.

1.1.6.3 Wetlands and Floodplains

During the 1994 U.S. Army Corps of Engineers (COE) environmental investigations, 11,719 acres of wetlands were found in areas surrounding the PGDP. These investigations identified 1,083 separate wetland areas and grouped them into 16 vegetative cover types encompassing forested, scrub/shrub, and emergent wetlands (COE 1994b). Wetland vegetation consists of species such as sedges, rushes, spikerushes, and various other grasses and forbs in the emergent portions; red maple, sweet gum, oaks, and hickories in the forested portions; and black willow and various other saplings of forested species in the thicket portions.

At the PGDP, three bodies of water cause most area flooding: the Ohio River, Bayou Creek, and Little Bayou Creek. A floodplain analysis performed by COE (1994b) found that much of the built-up portions of the plant lie outside the 100- and 500-year floodplains of these streams. In addition, this analysis reports that ditches within the plant area can contain the expected 100- and 500-year discharges.

1.2 SURFACE WATER OPERABLE UNIT STRATEGY

The SWOU is one of five media-specific OUs at PGDP being used to evaluate and implement remedial actions. DOE, EPA, and the Commonwealth of Kentucky have agreed upon five media-specific strategic cleanup initiatives as follows [from Site Management Plan (SMP), DOE 2007a]:

- Burial Grounds OU Strategic Initiative,
- D&D OU Strategic Initiative,
- Groundwater OU Strategic Initiative,
- Soils OU Strategic Initiative, and
- SWOU Strategic Initiative.

These initiatives 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 gaseous diffusion plant once it ceases operation. These initiatives will be followed by a Comprehensive Site Operable Unit (CSOU) 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 2007a) and in the FFA (EPA 1998a).

The primary objectives of these initiatives are to protect human health and the environment by taking actions necessary to prevent both on-site and off-site human exposure that presents an unacceptable risk, to provide safe environmental conditions for industrial workers performing ongoing gaseous diffusion plant operations, and to implement actions that provide the greatest opportunities to achieve significant risk reduction before site closure.

For the SWOU, and consistent with EPA guidance (EPA 1998b; EPA 2005), a phased approach is used to meet the primary objectives. A phased approach is used because the complex surface water contamination problems at the site (i.e., ongoing operational activities, multiple sources of contamination, and a complicated contaminant fate and transport process) prevent PGDP from implementing one comprehensive, cost-effective remedy at this time. Additionally, the phased approach allows the site to use information gained in earlier phases of the cleanup to refine and implement subsequent cleanup objectives and actions.

The phased approach for the SWOU consists of implementing a series of steps that will meet short-term protection goals, intermediate performance goals, and long-term, final cleanup goals. Sequencing the steps in this manner is consistent with EPA's recommendation to use these goals to accomplish the following EPA objectives (EPA 2005):

- Control sources early by focusing resources at areas that warrant attention in the near term, prioritizing actions within areas to address the greatest risks first;
- Minimize human exposure to contaminants, maximizing the effectiveness of institutional controls;
- Control further migration of contaminated sediment;
- Reduce risk from contaminated sediment hot spots; and
- Make progress toward the ultimate goal of protecting recreational users and industrial workers from exposure to contaminated surface water and sediment.

As described in the SMP (DOE 2007a), the following four steps are being used at PGDP to implement the phased approach for the SWOU:

(1) Prevent human exposure to contamination presenting an unacceptable risk (short-term protection goal);

(2) Prevent or minimize further off-site migration (intermediate performance goals);

(3) Reduce, control, or minimize surface water sources contributing to off-site contamination (intermediate performance goals); and

(4) Evaluate and select long-term solutions for off-site surface water contamination to protect human health and the environment (long-term, final cleanup goals).

In implementing this phased approach, the following SWOU actions have been implemented to meet the short-term goal of preventing human exposure to contaminated surface water and sediments (and fish):

- Posting of warning signs, fencing, and fish advisories at various ditches and creeks (1993); and
- Implementation of on-site institutional controls (1993).

The following additional actions have been taken for the SWOU to meet the intermediate performance goal of reducing, controlling, or minimizing contaminated surface water, sediment off-site migration, and contributing source areas:

- Installed inverted pipe dams at outfall ditches (mid 1980s);

- Removed approximately 5,000 drums of polychlorinated biphenyl- (PCB-) contaminated soils from vaporizer areas in C-337-A (1985–1986) and C-333-A (1987);

- Stabilized and mitigated PCBs in Outfall 011 ditch:

  — Removed approximately 1,300 drums of PCB-contaminated sediments (1983);
  — Cleaned ditch and installed fabric liner (1994);
  — Applied liquid boot, bentonite, and native clay (1995);
  — Implemented bioremediation technology (1996);

- Rerouted discharges at the NSDD and initiated treatment of radiologically contaminated waste waters from C-400 prior to discharge (1995);

- Installed fly ash collection basin at C-600 (1995);

- Removed PCB-contaminated soil at Waste Area Group (WAG) 23 (1997);

- Stabilized and mitigated PCBs in Outfall 011- ditch (1998);

- Completed Drum Mountain Removal Action (2000);

- Installed the C-613 Sedimentation Basin (2003);

- Installed the NSDD Hardpiping Installation (2003);

- Plugged culverts in NSDD at north security fence (2004);

- Completed NSDD Source Removal-Section 1 and Section 2 (2004); and

- Completed Scrap Yard Removal Action-source removal (2007).

SWOU (On-Site) represents an incremental step in the phased approach toward meeting the long-term final cleanup goals for the SWOU.[5] SWOU (On-Site) is an interim action consistent with the intermediate performance goals for the SWOU.

Upon completion of SWOU (On-Site), and in keeping with the phased approach, SWOU (On-Site) will be followed by SWOU (Off-Site) and the CSOU. SWOU (Off-Site) and the CSOU are designed to collectively meet long-term, final cleanup goals and will address restoration of contaminated surface water and comprehensively evaluate surface water as a part of a Remedial Investigation/Feasibility Study, including the evaluation of appropriate Water Quality Criteria and further evaluation of ecological risk.

1.3 PREVIOUS INVESTIGATIONS AND RESPONSE ACTIONS

The internal plant ditches and storm sewers that discharge to NSDD and the outfalls were trenched when PGDP was built and became fully operational when the plant was opened in 1951. The water quality of

[5] Consistent with the FFA, removal actions shall, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action with respect to the release concerned (FFA, Section X.A) (EPA 1998a).

each outfall is regulated by a KPDES permit, and the water quality is tested regularly at established monitoring stations, in accordance with the conditions of the permit.

1.3.1 NSDD Sections 3, 4, and 5

1.3.1.1 Previous Investigations

NSDD Sections 3, 4, and 5 (Figure 5) previously have been sampled as part of Phase I (CH2M HILL 1991) and II (CH2M HILL 1992) Investigations and, most recently, during the SI for SWOU On-Site. Sections 1 and 2 of the NSDD inside the PGDP fence (upstream of Sections 3, 4, and 5) have had response actions as noted herein.

1.3.1.2 Previous Actions

Historically, the NSDD received wastewater from the C-400 Cleaning Building, coal pile runoff, and storm water. The primary functions of the C-400 Cleaning Building included cleaning, metal plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and uranium tetrafluoride (green salt) pulverization. Sources of storm water runoff to the ditch include a steam plant (C-600), process buildings (C-335 and C-337), a cooling tower (C-635), the north side of the electrical switchyards (C-535 and C-537), a neutralizing pit (C-403), and a feed plant (C-410).

In 1977, the C-616-C Lift Station was constructed approximately 145 m (475 ft) upstream of the plant security fence. This lift station diverts all normal flow from upstream locations in the NSDD to the C-616-F Full Flow Lagoon for settlement of suspended solids prior to discharge through the KPDES Outfall 001 ditch system to Bayou Creek.

In 1982, a portion of the NSDD (Section 4) located north of Ogden Landing Road was relocated to its present configuration to facilitate construction of the C-746-S and C-746-T Landfills. The former segment of the NSDD was filled and abandoned and now is located under the C-746-S and C-746-T Landfills. The abandoned segment of the ditch is not within the scope of this action. Remediation of the abandoned segment, now a portion of SWMU 145, will be addressed as part of any remedial actions for SWMU 145, which is contained in the Burial Grounds OU.

The C-616-H Lift Station (Ditch 001 Lift Station) began operation in 1991. This lift station pumps effluent of the C-335 and C-337 Process Buildings and the C-535 and C-537 Switchyards into the NSDD for downstream capture by the C-616-C Lift Station and treatment through the C-616-F Full Flow Lagoon.

In 1992, an Interim Corrective Measure (ICM) included the installation of fencing and signs to restrict access to Little Bayou Creek and portions of the NSDD located outside the PGDP security fence (DOE 1992). Warning signs were installed along the NSDD north of the PGDP security fence to Ogden Landing Road. These signs warn that the ditch is contaminated and should not be used for drinking, recreational, or fishing purposes.

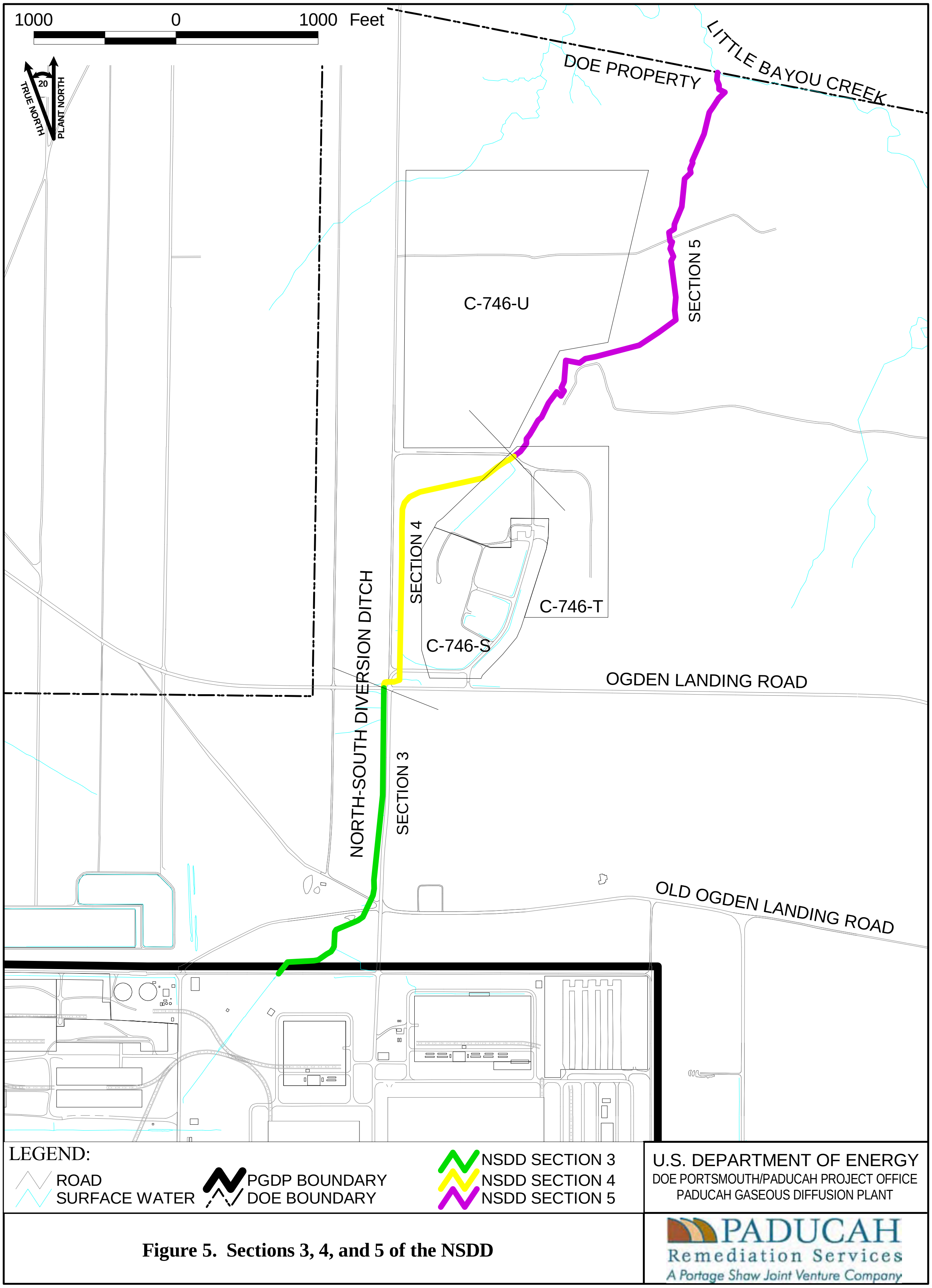


Figure 5. Sections 3, 4, and 5 of the NSDD

Figure No. C5AC90005sk001.apr
DATE 08-17-06

In March 1994, DOE and EPA, with the concurrence of the Kentucky Department for Environmental Protection (KDEP), signed a Record of Decision (ROD) for an interim action at the NSDD as an incremental step toward addressing sitewide problems (DOE 1994a). The primary objectives of the interim action were to mitigate the discharge of contaminants into the NSDD, decrease the off-site migration of contaminants already present in the NSDD, and decrease the potential for worker exposure (i.e., direct human contact) to the contaminants within the ditch (DOE 1994a). The interim remedial action (IRA) consisted of the following activities.

- An ion exchange system was installed in the C-400 Building to reduce radionuclide levels in the effluent to be discharged to the NSDD.

- Fly ash was removed from the C-600 Steam Plant effluent discharged to the NSDD.

- Flow from the sediment-filled southern end of the NSDD was piped northward to the C-616-H Lift Station to reduce the potential for mobilization of contaminants. This was accomplished by constructing a lift station (C-400-L) near the southern end of the NSDD.

- A gabion-type rock structure was constructed in the NSDD upstream of the C-616-H Lift Station to trap sediment and mitigate the potential for sediment transport to off-site areas from the portion of the NSDD that was bypassed with the piping (i.e., the section from the C-400-L Lift Station to the C-616-H Lift Station).

- Warning signs were installed on both sides of the portions of the NSDD inside the security fence from Virginia Avenue to the C-616-C Lift Station. These signs provide notice that elevated levels of radionuclides, metals, and PCBs are present in the area.

Construction of the IRA was completed during August 1995 (DOE 1995). Once construction was completed, two components of the actions, the C-400 Ion Exchange and C-600 Fly Ash Lagoons, were incorporated into the daily operations of the PGDP by USEC, and the discharge from the C-400 Ion Exchange system was routed into the Outfall 009 storm water drain to eliminate discharges from the C-400 Building to the NSDD. The C-600 Fly Ash Lagoons eliminated fly ash deposition in the NSDD.

In 1999, institutional controls were erected along Sections 3 and 4 of the NSDD to comply with 10 *CFR* Part 835. These controls consisted of radiological barriers (i.e., yellow and magenta chains), "Fixed Contamination Area" signs, and "10 *CFR* 835" explanation signs.

On October 10, 2002, an interim ROD for NSDD Sections 1 and 2 was signed by EPA and DOE with concurrence from the Commonwealth of Kentucky (DOE 2002a). The interim action taken at the NSDD was designed to protect human health and the environment in the short-term by providing adequate protection until a final ROD is signed for the SWOU. The primary objectives of the interim action were to mitigate the introduction of contaminants into the NSDD, decrease the migration of contaminants already present in the NSDD, and decrease the potential for direct human contact with the contaminated material. Implementation of the remedial action for Sections 1 and 2 was accomplished in two phases and included the following activities:

- Installation of piping to route process discharges that currently pass through the NSDD to the C-616 Water Treatment Facility;

- Plugging of the culverts in the NSDD at the PGDP security fence and in three other ditches within the NSDD watershed to prevent discharge of on-site storm water runoff to sections of the NSDD outside the PGDP security fence; and

- Excavation of a surge basin to contain storm-water runoff until it can be routed through the C-616 facility.

Phase II activities were initiated upon completion of construction of the surge basin and consisted of complete excavation of contaminated soils and sediments along Sections 1 and 2 of the NSDD up to a total depth of 4 ft. Following completion of excavation activities, the ditch channel was restored to grade with 2 ft of clay cover and approximately 2 ft of clean soil and then revegetated.

DEFINITION OF A POTENTIAL "HOT SPOT" AS USED IN THE SWOU SAP AND SI/BRA

A potential "hot spot" is characterized by an area in which one or more indicator chemicals exceeded an indicator level or one or more analytes exceeded an analyte's characterization level as established in the SWOU (On-site) SAP (DOE 2005). The indicator level is the value to which an indicator's detected concentration is compared. If the indicator chemical has a detected concentration greater than its indicator level, then one or more contaminants may be present at the sampling location at concentrations greater than their characterization level. The characterization level is a risk-based concentration developed to meet the objectives of the SWOU (On-Site) project. Please see Appendix C.5 of the SAP (DOE 2005) for additional information on derivation of indicator and characterization levels. It should be noted that neither indicator nor characterization levels should be considered cleanup goals.

In 2005, DOE implemented the Sampling and Analysis Plan (SAP) for the Site Investigation/Baseline Risk Assessment (SI/BRA) of the SWOU (On-Site) (DOE 2005) and submitted the report on November 14, 2006. For the NSDD, the objective of the SI for the Surface Water (On-Site) was to provide information concerning the identification of potential "hot spots"[6] in Sections 3, 4, and 5 that may be contributing to off-site migration and risks to human health and the environment posed by the contamination migrating from these potential "hot spots." The resulting data were used in the BRA to develop exposure point concentrations (EPCs) for each exposure unit (EU). In addition, the SI provided information useful for determining the need for hot spot removal. The SI/BRA for the SWOU (DOE 2006) presented the following conclusions for the NSDD (Sections 3, 4, and 5):

- Potential "hot spots" are present in the NSDD (Sections 3, 4, and 5).

- Human health risks greater than the EPA risk range may exist under some scenarios; however, under site-specific current scenarios, risk falls within the EPA risk range.

- Future evaluations of ecological risk may need to be performed.

Of the 44.9 acres of total source area investigated, 3.9 acres were identified as potential "hot spots" with 1.8 acres (46 percent) located within the NSDD Sections 3, 4,and 5 (DOE 2006). Within the 3.9 acres, there were 26 potential "hot spots" identified, indicating that unacceptable risks for human health and the environment could exist. Eight of the 26 locations are within the NSDD (Sections 3, 4, and 5).

[6] A potential "hot spot" is characterized by an area in which one or more indicator chemicals exceeded an indicator level or one or more analytes exceeded an analyte's characterization level as established in the SWOU (On-Site) SAP (DOE 2005). The indicator level is the value to which an indicator's detected concentration is compared. If the indicator chemical has a detected concentration greater than its indicator level, then one or more contaminants may be present at the sampling location at concentrations greater than their characterization level. The characterization level is a risk-based concentration developed to meet the objectives of the SWOU (On-Site) project. Please see Appendix C.5 of the SAP (DOE 2005) for additional information on derivation of indicator and characterization levels. It should be noted that neither indicator nor characterization levels should be considered cleanup goals.

1.3.2 Outfalls 001, 002, 008, 010, 011, 012, 015 and Associated Internal Ditches

1.3.2.1 Previous Investigations

Contamination in the sediments of outfalls (Figure 6) has been characterized in several previous investigations including the Phase I SI (CH2M HILL 1991); Phase II SI (CH2M HILL 1992); WAG 15 (DOE 1996a); WAG 22 (DOE 1994b); WAG 23 PCB action (DOE 1997a); SWMUs 7 and 30 Remedial Investigation (RI) (DOE 1998); WAG 27 RI (DOE 1999); Site Evaluation of effluent ditches 010, 011, and 012 (DOE 1995); 1996 PCB Study of the COE (COE 1996); and, most recently, during the SI for SWOU On-Site (DOE 2006). The Phase II SI results (CH2M HILL 1992) also were included as part of the *Remedial Investigation Addendum for WAG 22 Burial Grounds at Paducah Gaseous Diffusion Plant* (DOE 1994b) and of the *Preliminary Site Characterization/Baseline Risk Assessment for the Lasagna™ Technology Demonstration* (Clausen 1996).

1.3.2.2 Previous Actions

Due to concerns about the presence of PCBs and radiological contamination in outfalls at the plant, DOE issued the *Interim Corrective Measures Work Plan for Institutional Control of Off-Site Contamination in Surface Water* (DOE 1992). This ICM restricted public access to creeks, outfalls, and lagoons surrounding the PGDP at ten locations for any personnel not directly associated with the plant or not conducting plant work-related activities. Access restriction was accomplished through the installation of fencing and the posting of warning signs at various off-site locations. Subsequently, in 2000, additional warning signs were posted that identified the creeks, outfalls, and lagoons as contaminated areas.

In the early 1980s, an oil containment lagoon and oil control structure at SWMU 63 (Outfall 008 Oil Skimmer Ditch) were constructed to contain discharges of oil released to Outfall 008 from operations at the C-600 Steam Plant.

In 1983, Outfall ditch 011 was included in an extensive PCB "hot spot" removal action conducted by DOE. During this action, approximately 1,300 drums of PCB-contaminated sediments were removed sitewide, some of which exhibited PCB concentrations as high as 2,000 mg/kg. Historical records indicate that the PCB cleanup level for the remediation was 25 mg/kg (DOE 1997a).

There have been no CERCLA actions for the internal plant ditches to Outfall 011; however, DOE has implemented several remedial measures and treatability studies in areas of Outfall 011 located outside of the plant security fence. In the early 1980s, DOE excavated the upper 0.46 m (1.5 ft) of sediment in the Outfall 011 ditch from the PGDP security fence to Dykes Road to remove PCB contamination, and the ditch was restored with clean material.

In 1994, DOE received two notice of violations from the Commonwealth of Kentucky due to PCB exceedances in surface water at Outfall 011. These exceedances were related to resuspension of PCB- (PCB-1248, PCB-1260, and Total PCBs) contaminated sediment in the ditch, as water discharges flowed to Little Bayou Creek. To address this issue, the discharge of water from the C-617 Treatment Lagoon was diverted from Outfall 011 to Outfall 010 after June 8, 1994. This removed surface water flow from Outfall 011 except during high-flow rain events. Also during 1994, the portion of Outfall ditch 011 between Dykes Road and the flume was riprapped and silt fences were installed around areas of known contamination. In 1995, DOE coated the Outfall 011 ditch with a bentonite concentrate to prevent erosion and further contaminant migration.

DOCUMENT No. DOE/LX/07-0012

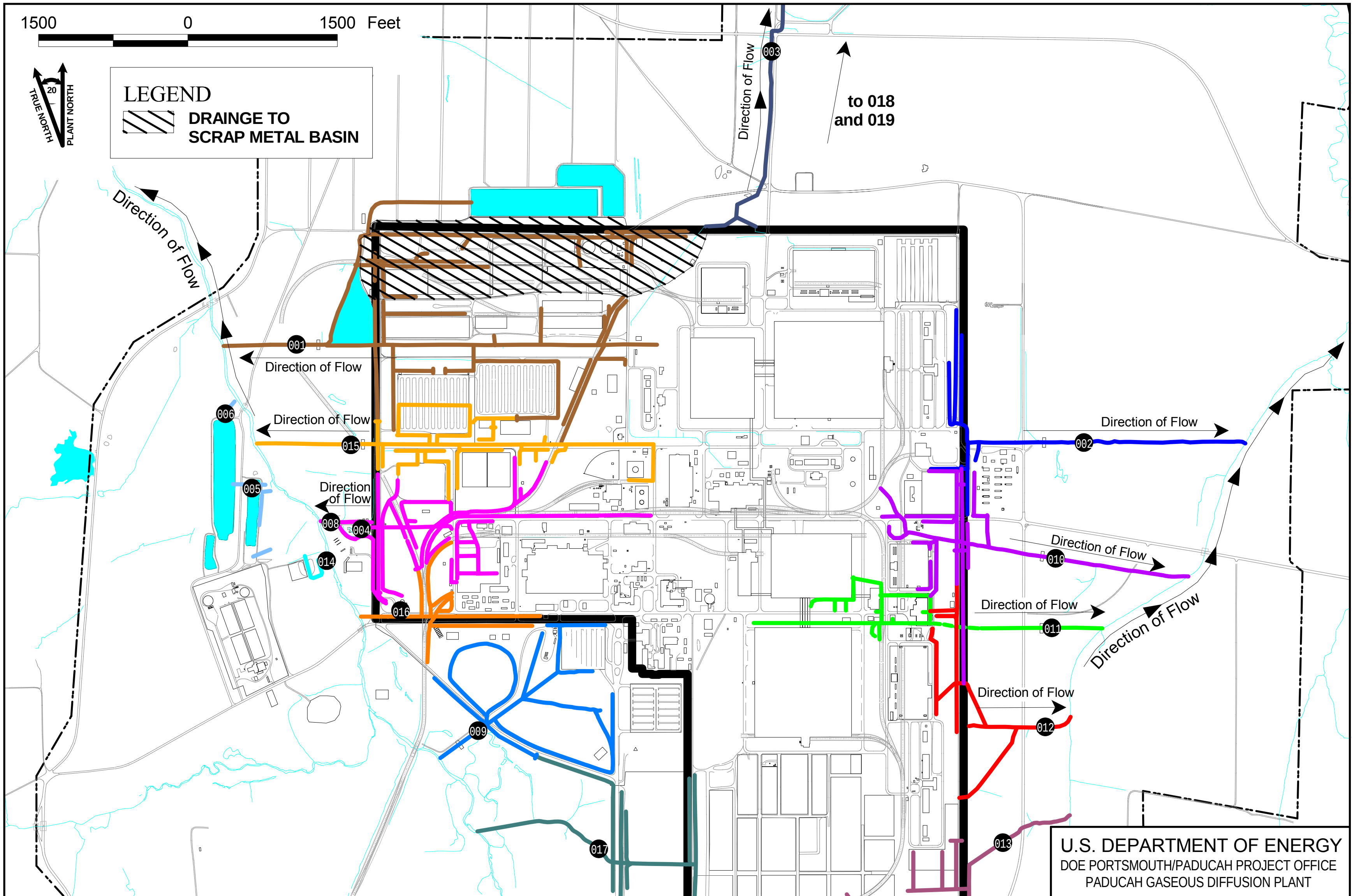


Figure 6. KPDES Outfall Locations and Generalized Surface Water Flow Patterns at PGDP

Figure No. c5ac90005sk002.apr
DATE 02-21-07

In an effort to minimize/eliminate further PCB releases at PGDP, DOE performed a Nature's Way bioremediation technology field demonstration in the summer of 1996. A 15.24-m (50-ft) section of the Outfall 011 ditch was chosen as the demonstration-site. During the demonstration, a polyvinyl chloride (PVC) distribution system was installed in the Outfall 011 ditch where the highest levels of PCB contamination (35 mg/kg) were found during the 1995 PCB soil characterization. The system consisted of a series of vertical PVC pipes placed in drilled holes to a depth of 30.48 cm (12 in.) throughout the 15.24-m (50-ft) demonstration area. The vertical pipes were connected to a horizontal manifold system and a nutrient bacteria solution was fed into the manifold system for distribution into the PCB-laden sediment. This application was performed approximately twice per week for the duration of the test from July 23 through December 15, 1996. Test results were monitored by a series of sampling events conducted during the last two quarters of 1996. For each sampling event, the 15.24-m (50-ft) section test area was divided into three equal sections. A single soil sample then was composited from three randomly chosen sampling locations within each section. Monitoring results indicated that the bacteria were effective for reducing PCB contamination within the 15.24-m (50-ft) demonstration segment to levels of approximately 10 mg/kg; however, test results indicating further reduction of contaminant levels below 10 mg/kg were inconclusive (LMES 1997).

In 2005, DOE implemented the SAP for the SI/BRA of the SWOU (On-Site) (DOE 2005) and submitted the report on November 14, 2006. For the outfalls and their associated internal ditches, the objective of the SI for the Surface Water (On-Site) was to provide information concerning the identification of potential "hot spots" in internal plant ditches and outfalls that may be contributing to off-site migration and risks to human health and the environment posed by the contamination migrating from these potential "hot spots." The resulting data were used to develop source terms to support transport modeling and in the BRA to develop EPCs for each EU. In addition, the SI provided information useful for determining the need for hot spot removal and the evaluation of whether additional sediment control measures are needed. The SI/BRA for the SWOU (DOE 2006) presented the following conclusions for the outfalls and their associated internal ditches.

- Potential "hot spots" are present in the on-site ditches and associated areas.

- Human health risks greater than the EPA risk range may exist under some scenarios; however, under site-specific current scenarios, risk falls within the EPA risk range.

- Based upon the modeling performed as part of the SI report for the outfalls and their associated internal ditches, no contaminants are migrating in surface water (dissolved or through sediment) from ditches to surrounding creeks at concentrations that may adversely impact human health.

- Future evaluations of ecological risk may need to be performed.

Of the 44.9 acres of total source area investigated, 3.9 acres were identified as potential "hot spots," with 2.1 acres (54 percent) located within the outfalls and their associated internal ditches (DOE 2006). Within the 3.9 acres, there were 26 potential "hot spots" identified, indicating that unacceptable risks for human health and the environment could exist. Eighteen of the 26 locations are within outfall ditches 001, 008, 010, 011, and 015. Additionally, one area within Outfall 010 had concentrations of Total PCBs greater than 50 parts per million.

1.3.3 PGDP Storm Sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537

1.3.3.1 Previous Investigations

The storm sewers (Figures 7 through 9) have not had any previous response actions; however, the storm sewers at C-333-A and C-337-A were characterized for PCB by the COE (COE 1992), the Oak Ridge National Laboratory (DOE 1996b), and, most recently, during the SI for the SWOU On-Site.

1.3.3.2 Previous Actions

In 2005, DOE implemented the SAP for the SI/BRA of the SWOU (On-Site) (DOE 2005) and submitted the report on November 14, 2006. For the C-333-A, C-337-A, C-340, C-535, and C-537 storm sewers, the objective of the SI for the Surface Water (On-Site) was to provide information concerning the identification of potential "hot spots" in the storm sewer system that may be contributing to off-site migration and risks to human health and the environment posed by the contamination migrating from these potential "hot spots." The resulting data were used in the BRA to develop EPCs for each EU. In addition, the SI provided information useful for determining actions for potential legacy releases associated with the storm sewer system. The SI/BRA for the SWOU (DOE 2006) presented the following conclusions for the storm sewer system:

- For all storm sewer locations, the contaminant concentrations for total PCB, trichloroethene (TCE), and total uranium were below levels that could indicate unacceptable risk; therefore, they are not considered to be a source for these contaminants.

Except for the SI/BRA, there have been no other actions for the storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537.

1.4 ANALYTICAL DATA

Analytical data from previous investigations that were representative of current site conditions and met the requirements of the Risk Methods Document as well as the extensive data collected during the most recent SI for SWOU On-Site were utilized in support of this evaluation. These datasets have been verified, validated, and assessed. The datasets were determined to meet the SWOU On-Site project goals and determined acceptable for use in decision making. Potential source areas, as determined by the analytical results, were examined, and potential site-related contaminants were identified. Appendix D provides the complete dataset utilized, including data qualifiers.

1.5 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The source, nature, and extent of the potential chemical contamination associated with specific areas or defined EUs located within PGDP Outfalls 001, 008, 010, 011, and 015, and their associated internal ditches and specific areas or EUs located within the NSDD Sections 3, 4, and 5 have been defined by the SWOU (On-Site) SI/BRA report (DOE 2006). These identified areas contain contamination within the upper one foot of surface soil/sediment. The identified contamination was derived from various plant activities conducted at PGDP facilities and exceeds the indicator levels defined in the SI, indicating that human health risks greater than the EPA risk range may exist under some scenarios.

DOCUMENT No. DOE/LX/07-0012

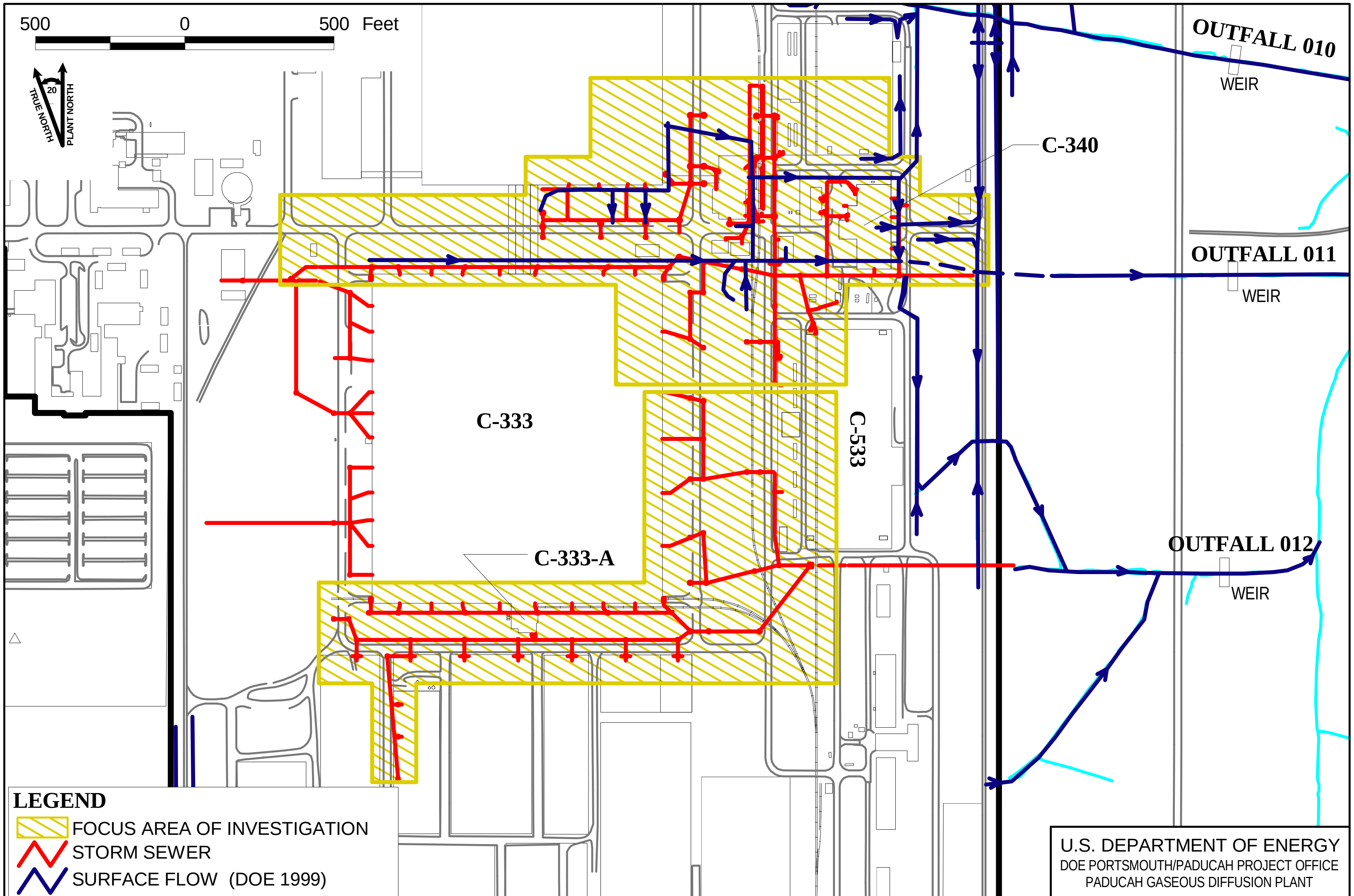
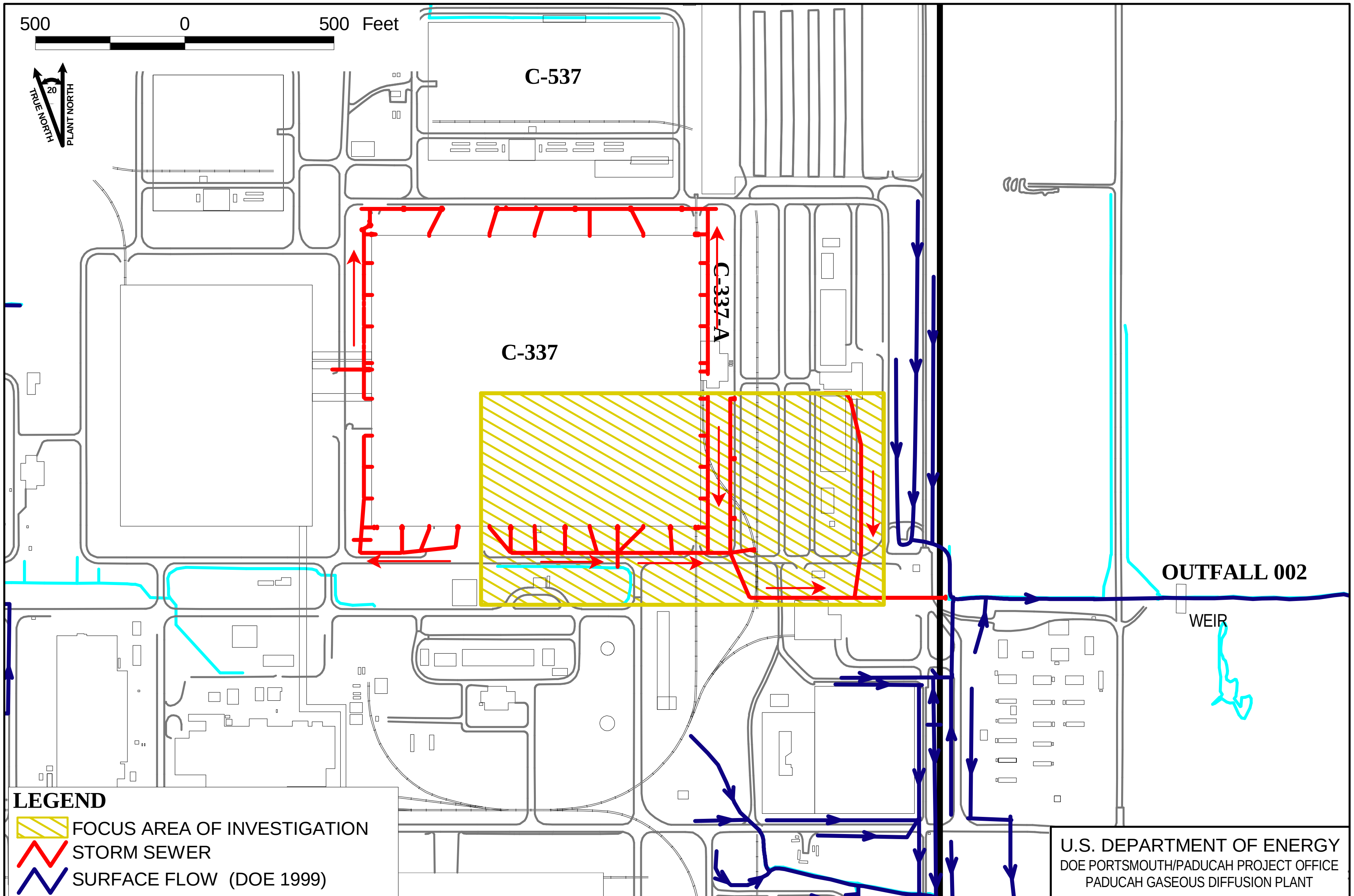


Figure 7. Location of Storm Sewers near C-333 and C-340

Figure No. 669_stormsewer.apr
DATE 08-17-06

DOCUMENT No. DOE/LX/07-0012



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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure 8. Location of Storm Sewers near C-337

Figure No. 669_stormsewer.apr
DATE 08-17-06

DOCUMENT No. DOE/LX/07-0012

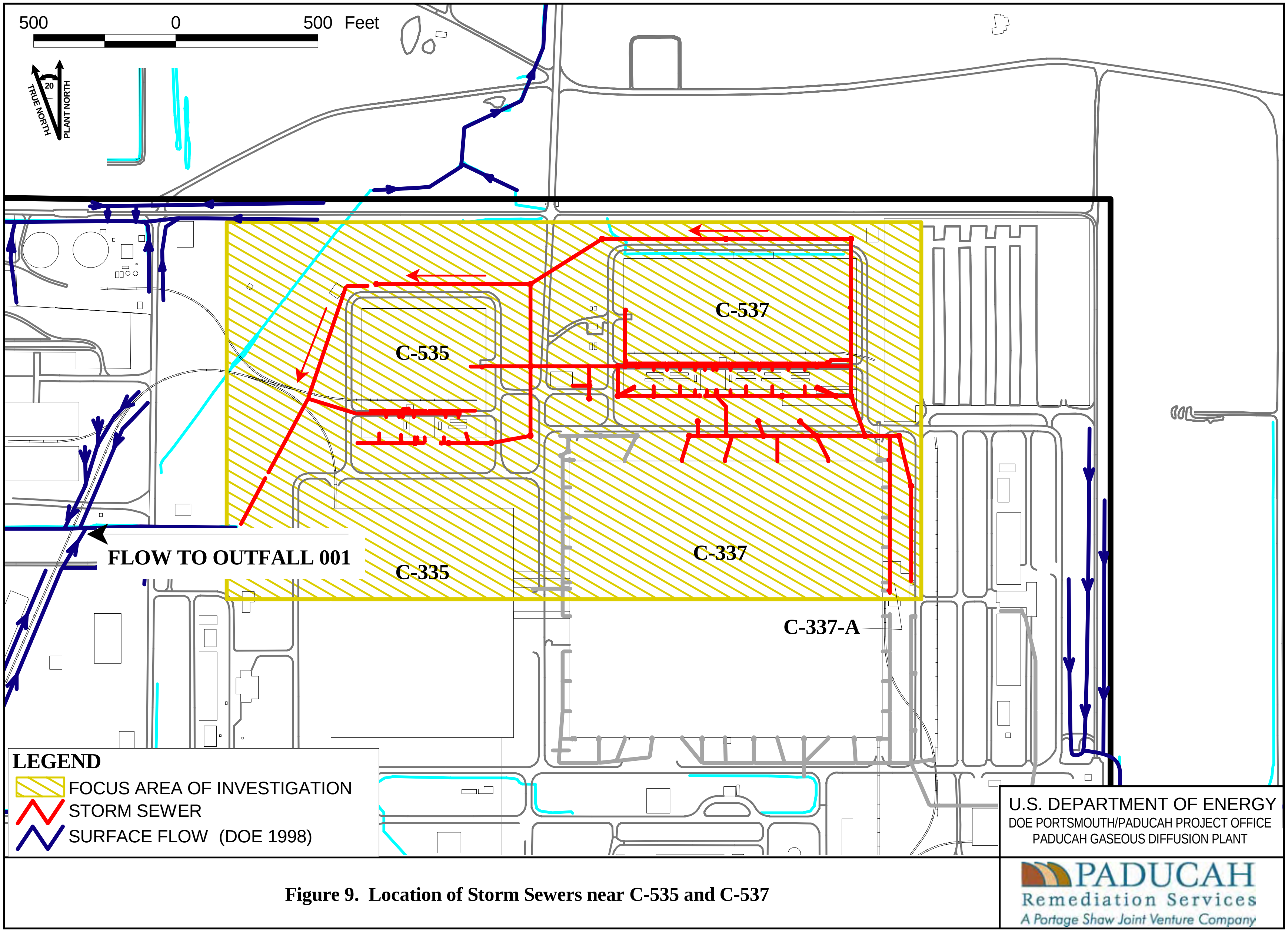


Figure 9. Location of Storm Sewers near C-535 and C-537

Figure No. 669_stormsewer.apr
DATE 08-21-06

1.5.1 NSDD Sections 3, 4, and 5

Potential "hot spots" for radiological constituents, PCBs, and metals have been identified within the following locations:

- NSDD Section 3 (EUs 01, 02, and 03)
- NSDD Section 4 (EU 06)
- NSDD Section 5 (EUs 07, 08, 09, and 10)

1.5.2 Outfalls 001, 002, 008, 010, 011, 012, 015, and Associated Internal Ditches

Potential "hot spots" for radiological constituents, PCB, metals, and polycyclic aromatic hydrocarbon compounds (PAHs) have been identified within the following locations:

- Outfall 001 (EUs 07, 14, 15, 16, 18, 19, and 21)
- Outfall 008 (EU 13)
- Outfall 010 (EUs 04, 06, and 10)
- Outfall 011 (EU 01)
- Outfall 015 (EUs 02, 03, 04, 06, 07, and 10)

It should be noted that no potential "hot spots" were identified at Outfall 002 and Outfall 012.

1.5.3 PGDP Storm Sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537

The contaminant concentrations for Total PCB, TCE, and Total uranium determined during the SI for the SWOU (On-Site) for the storm sewers were below levels that could indicate unacceptable risk. As a result, the storm sewers were not considered to be a source for these contaminants. During the SI, a total of approximately 16,360 linear feet of storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 was investigated for PCB, TCE, and Total uranium (DOE 2006).

1.6 CONTAMINANT FATE AND TRANSPORT

Fate and transport modeling was used to estimate contaminant concentrations at selected points of exposure. The potential migration pathways and mechanisms for transport of chemical and radiological substances found in surface soils and sediments at PGDP were evaluated using the Modified Universal Soil Loss Equation (MUSLE) (Mills et al. 1982) and the Storm Water Management Model (SWMM) (Huber and Dickinson 1988). The points of exposure considered were within the outfalls (just before mixing in the creeks); within the creeks (at the point where each of the outfalls discharges to the surrounding creeks); and at the creek integrator points located downgradient of all outfalls. The predicted contaminant concentrations were compared to no action screening levels. These screening levels are not based on site-specific exposure scenarios and should not be considered cleanup goals for the SWOU.

The initial step of the fate and transport modeling considered the risk assessment results for direct contact with contaminated sediment and identified the contaminants that might pose the greatest risk through migration to off-site locations. This step identified antimony, iron, uranium, Total PCBs, Total PAHs, and uranium-238 as preliminary chemicals of potential concern (COPCs) to include in the MUSLE modeling. The MUSLE results based on sediment concentrations in the runoff indicated that Total PAHs were predicted potentially to be above the risk-based screening levels protective of the recreational user and industrial worker at Outfall 011. The MUSLE results based on surface water concentration indicated that only Total PAHs and uranium were likely to migrate to off-site locations at concentrations above risk-based screening levels protective of the recreational user and industrial worker. Additional evaluation of these screening results, the data available for source term delineation, and the goals of the SI determined that neither Total PAHs nor uranium required more sophisticated SWMM modeling. However, this evaluation did determine that SWMM modeling for Total PCBs and uranium-238 was appropriate in order to verify the MUSLE results for these important sitewide contaminants and to meet the goals of the SI.

For SWMM modeling, potential "hot spot" areas were developed within EUs for Total PCBs and uranium-238. The EUs potentially contributing to surface water contamination were assigned by geographic information system analysis to the outfalls to which they drain. Source terms for Total PCBs and uranium-238 were developed for the EUs that potentially contribute to surface water contamination.

Results of the SWMM modeling, which were based on a 30-year simulation period, indicated that Total PCB concentrations may exceed the child recreational and industrial worker no action screening levels for surface water within Outfall 001, 008, 010, and 015 (just before mixing in the creeks). Predicted Total PCB concentrations within the creeks and at the creek integrator points did not exceed no action screening levels. SWMM modeling also indicated that the uranium-238 concentration within Outfall 001 (just before mixing in the creeks) may exceed the no action child recreational screening level. As with Total PCBs, predicted uranium-238 concentrations within the creeks and at creek integrator points did not exceed no action screening levels.

In summary, based upon the modeling performed as part of the SI report for the outfalls and their associated internal ditches, no contaminants are migrating in surface water (dissolved or through sediment) from ditches to surrounding creeks at concentrations that may adversely impact human health.

1.7 SUMMARY OF RISK ASSESSMENT

A baseline human health risk assessment (BHHRA) and screening ecological risk assessment (SERA) were completed as part of the SWOU (On-Site) SI/BRA report (DOE 2006). Section 1.7.1 summarizes the results of the SI/BRA BHHRA, and Section 1.7.2 summarizes the results of the SI/BRA SERA. Appendix E discusses the development of the removal goal options (RGOs) for the contaminants of concern (COCs) identified by the SI/BRA BHHRA.

1.7.1 Human Health Risk

COPCs were identified and carried through the BHHRA. The list of COPCs initially was narrowed to those chemicals identified in Table 5.1 of the SAP for the SI/BRA of the SWOU (On-Site) (DOE 2005). Completion of additional screening steps resulted in the development of a final list of COPCs. Additional information concerning the process used to select the final list of COPCs and the impact of uncertainties in the COPC selection process on the selection of COCs and the development of RGOs is presented in Appendix E.

To evaluate human health risks based on exposure to SWOU media, the data were segregated into 13 EUs. Each EU was a distinctive area within the site that, because of similar levels of contamination or because of similar expected human activity patterns, reasonably could be assessed as a single unit, using single EPCs for COPCs. The EUs were delineated by plotting three indicator chemicals (Total PCBs, cesium-137, and uranium-238) detected in soil and sediment using Spatial Analysis and Decision Assistance (SADA) to determine locations with concentrations greater than no action levels. [The indicator chemicals were identified in the SAP for the SI/BRA of the SWOU (On-Site) (DOE 2005).] The no action levels that were used were levels calculated for recreational users, industrial workers, and excavation workers. Further, the EUs were delineated as areas of the site with similar levels of contamination. The resulting data plots revealed 11 distinctive potential "hot spot" areas and each was evaluated as a separate EU. The remaining areas, excluding potential "hot spots" (i.e., indicator chemical concentrations less than the no action levels), were grouped into two EUs based on physical location relative to the PGDP ("Within the Fence, Excluding Hot Spots" and "NSDD, Excluding the Hot Spot"). The EUs are summarized as follows [and are presented in Appendix D, Attachment D.2, and Figures D.2 through D.10 of the SWOU (On-Site SI/BRA report (DOE 2006)]:

- Outfall 008 Hot Spot
- Outfall 010 Hot Spot
- Outfall 011 Hot Spot
- Outfall 015 Hot Spot
- Outfall 001, EU 13 Hot Spot
- Outfall 001, EU 14 Hot Spot
- Outfall 001, EU 15 Hot Spot
- Outfall 001, EU 16 Hot Spot
- Outfall 001, EU 18 Hot Spot
- Outfall 001, EU 20 Hot Spot
- Within the Fence, Excluding Hot Spots
- NSDD Hot Spot
- NSDD, Excluding Hot Spot

To assess risk at the 13 EUs, the BHHRA evaluated land use scenarios that encompass current use and/or foreseeable future land use. The land use exposure scenarios considered applicable to the SWOU were current and future industrial workers, future excavation workers, and current and future recreational users. The following exposures were assessed for site receptors within each EU:

- Current/Future Industrial Worker

    — Incidental ingestion of soil/sediment
    — Dermal contact with soil/sediment
    — Inhalation of particulates emitted from soil/sediment
    — External exposure to ionizing radiation emitted from soil/sediment
    — Dermal contact with surface water

- Excavation Worker

    — Incidental ingestion of soil/sediment
    — Dermal contact with soil/sediment
    — Inhalation of particulates emitted from soil/sediment
    — External exposure to ionizing radiation emitted from soil/sediment

- Current/Future Recreational User

    — Incidental ingestion of soil/sediment
    — Dermal contact with soil/sediment
    — Inhalation of particulates emitted from soil/sediment
    — External exposure to ionizing radiation emitted from soil/sediment

— Dermal contact with surface water
— Ingestion of deer grazing on vegetation grown in contaminated soil/sediment
— Ingestion of rabbit grazing on vegetation grown in contaminated soil/sediment
— Ingestion of quail grazing on vegetation grown in contaminated soil/sediment

The results by exposure scenario are summarized in Subsections 1.7.1.1 through 1.7.1.4.

1.7.1.1 Current Industrial Worker

Soil hazards [total hazard indexes (HIs)] for the current industrial worker were at or below a cumulative hazard estimate of 1 for all contact exposures associated with soil/sediment and for surface water at all EUs. A cumulative excess lifetime cancer risk (ELCR) greater than 1E-06 was estimated for all EUs, with a cumulative ELCR greater than 1E-04 estimated for two of the EUs for current industrial workers based on direct contact exposures to soil/sediment. Soil cancer risks (total ELCRs) for the current industrial worker exceeded 1E-04 at Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot. The major contaminants driving risk at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

1.7.1.2 Future Industrial Worker

Cumulative HIs for the future industrial worker were greater than 1 for all EUs based on soil/sediment contact exposures. Hazard estimates greater than 1 also were identified for two EUs (Outfall 001 EU 14 Hot Spot; and Within the Fence, Excluding the Hot Spots) due to surface water dermal exposure. Soil cancer risks (total ELCRs) for the future industrial worker exceeded 1E-06 at all EUs and 1E-04 at six locations (Outfall 008 Hot Spot, Outfall 10 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall 001 EU15 Hot Spot, and NSDD Hot Spot). The major contaminants driving hazard at all EUs are Total PCBs and Total PAHs (as BaPE), and the driving medium of concern was soil/sediment.

1.7.1.3 Excavation Worker

A cumulative HI greater than 1 was estimated for each EU for excavation workers at all EUs (with the exception of Outfall 001 EU 13 Hot Spot), with antimony, iron, uranium, and Total PCBs being the drivers of hazard and soil/sediment being the only medium of concern. A cumulative ELCR greater than 1E-06 was estimated for all EUs, with a cumulative ELCR at or greater than 1E-04 estimated for seven EUs (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 015 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall 001 EU 15 Hot Spot, and NSDD Hot Spot) based on direct contact exposures to soil/sediment. The major contaminants driving risk at all EUs are Total PCBs, Total PAHs (as BaPE), and thorium-230, and the driving medium of concern was soil/sediment.

1.7.1.4 Current/Future Recreational User

A cumulative HI for a current child recreational scenario employing site-specific exposure assumptions met the hazard limit of 1 and the ELCR was less than 1E-06 at the NSDD, Excluding the Hot Spot. The cumulative risk estimates included risks from direct contact with soil/sediment, dermal contact with surface water, and ingestion of game (i.e., deer, rabbit, and quail). The cumulative hazard estimate for the current child recreational user was greater than 1 and the ELCR was 1E-06 at the NSDD Hot Spot. The excess risk was due to dermal contact with soil/sediment, and the primary drivers of hazard and risk were antimony and uranium.

HI estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were below a hazard of 1. ELCR estimates for potential exposures for future recreational users (adult, teen, and child) associated with dermal contact with surface water and consumption of game were at or below 1E-06, with the exception of future teen dermal contact with surface water at the NSDD, Excluding the Hot Spot (Section 3, EUs 01 and 02).

Direct contact with sediment resulted in hazard estimates greater than 1 for future recreational users (adult, teen, and child) under default exposure assumptions at both the NSDD Hot Spot and the NSDD, Excluding the Hot Spot. All ELCRs for direct contact with sediment for each receptor were greater than 1E-06, but below 1E-04. The major contributors to risks and hazards for future adults, teens, and children included antimony, iron, uranium, and Total PCBs at both NSDD EUs and PCBs at the NSDD Hot Spot. The medium of concern was soil/sediment.

1.7.2 Human Health Risk Conclusions

The BHHRA concluded that cancer risk and noncancer hazard estimates for the current industrial worker and current recreational user (outside the security fence) were the appropriate receptors for decision-making for the SWOU. The resulting site-specific cancer risks for some EUs were above (e.g., current industrial worker) or fell within (e.g., current recreational user) the EPA risk range. Also, the site-specific noncancer hazard estimates for some EUs were greater than one.

1.7.3 Ecological Risk

A SERA was performed as outlined in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001). The objective of the SERA was to identify, qualitatively and quantitatively, where appropriate, the potential environmental risks associated with the SWOU at the PGDP that would exist if no further remedial action were taken.

Conservative assumptions were used in the SERA to indicate which contaminants and exposure pathways present at the site may pose ecological risks. Screening of COPCs was completed for surface water, sediment, and soil media in the NSDD (Sections 3, 4, and 5) and the outfalls and their associated internal ditches and areas. This screening used the no further action levels listed in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001) that are based upon the Kentucky water quality criteria (WQC) or other relevant concentrations when a WQC was not available. Food web modeling was completed for Total PCBs in the NSDD and Outfall 001 to assess the bioaccumulation potential of this chemical for a specific suite of mammalian and avian receptors. This screen provided risk estimates based on direct exposure (direct contact and ingestion) of aquatic and terrestrial biota to contaminated media.

1.7.3.1 Ecological Risk Uncertainties

The following sections outline some of the uncertainties identified while performing the ecological risk assessment:

- Lack of screening benchmarks for constituents,
- Lack of analytical data for constituents,
- Future land use and future habitat types,
- Species present or might be present at the PGDP site,

- Use of maximum detected concentration as exposure concentration and no further action values as screening criteria,
- Subsurface soil exposures,
- No further action values for silver,
- Multiple contaminant exposures,
- Food web model, and
- Hardness-dependent metal no further action values.

When considering these uncertainties in combination, it is possible that risks to ecological receptors were overestimated in the SERA and that the list of COPCs could be shorter if all uncertainties were addressed completely. Further evaluation consistent with the Baseline Ecological Risk Assessment (BERA) process would be necessary to identify more specifically the risks to ecological receptors at the PGDP site.

1.7.3.2 Ecological Risk Conclusions

Based upon the ecological screening, a large number of analytes were found to exceed no action levels and were retained as COPCs. Additionally, the PCB food web modeling revealed significant risks to several soil- and sediment-based receptors. Per EPA guidance and guidance in the PGDP Methods Document, these results indicate that further evaluation of potential for risk is required. If this further evaluation includes a BERA, it would include Steps 3-8 of the ERA process; however, it is believed that the proposed PCB remediation that will be completed as part of this EE/CA will reduce the associated PCB food web risk.

1.8 COMMUNITY PARTICIPATION

Community involvement is a necessary aspect of the CERCLA process. DOE is conducting community relations activities for this project in compliance with 40 *CFR* § 300.415(n)(1), (n)(3), and (n)(4), and the community relations plan, *Community Relations Plan Under the Federal Facility Agreement at the U.S. Department of Energy Paducah Gaseous Diffusion Plant* (DOE 2007b).

2. REMOVAL ACTION OBJECTIVES

This section addresses DOE's response authority under CERCLA for removal actions and identifies the scope, purpose, and general Removal Action Objectives (RAOs) for this removal action. Justification for the removal action also is addressed.

2.1 RESPONSE AUTHORITY

PGDP was placed on the NPL in 1994. Pursuant to Section 120 of CERCLA, the PGDP FFA was negotiated and implemented to provide the framework for site CERCLA actions.

Section 104 of CERCLA addresses the mitigation of releases or threatened releases of hazardous substances to the environment through response action. Executive Order 12580, "Superfund Implementation," delegates to DOE the authority for response actions at DOE facilities. As lead agency, DOE is authorized to conduct response measures (e.g., removal actions) under CERCLA.

The National Environmental Policy Act of 1969 (NEPA) requires federal agencies to evaluate and document the effect of their proposed actions on the quality of the human environment. DOE issued a *Secretarial Policy Statement* on NEPA in June of 1994 (DOE 1994a) stating that DOE hereafter will rely on the CERCLA process for review of actions to be taken under CERCLA and incorporate NEPA values in CERCLA documents to the extent practicable. Such values may include analysis of socioeconomic, cultural, ecological, and cumulative impacts, as well as environmental justice and land use issues and the impacts of off-site transportation of wastes. NEPA values have been incorporated into the EE/CA in accordance with the Secretarial Policy.

2.2 REMOVAL SCOPE AND PURPOSE

The purpose of this EE/CA is to evaluate alternatives to address the potential threat posed to human health from direct contact with hazardous substances in sediment[7] associated with NSDD Sections 3, 4, and 5 and PGDP Outfalls 001, 008, 010, 011, and 015 and their internal associated ditches.

2.3 REMOVAL ACTION OBJECTIVES

The overall Remedial Action Objectives that were established, as described in the SWOU (On-Site) SI for Sections 3, 4, and 5 of the NSDD and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches, are as follows.

- Control sources early by focusing resources at areas that warrant attention in the near term, prioritizing actions within areas to address the greatest risks first.

- Minimize human exposure to contaminants, maximizing the effectiveness of institutional controls.

[7] Sediment includes surface soil closely associated with ditches and outfalls.

- Control further migration of contaminated sediment.[8]

- Reduce risk from contaminated sediment hot spots.

- Reduce the risk, making progress toward the ultimate goal of protecting recreational users and industrial workers from exposure to contaminated surface water and sediment.

The Removal Action Objectives (RAOs) specific for this removal action are consistent with the overall Remedial Action Objectives for the SWOU and are as follows:

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

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

Details associated with the development of methods to meet these RAOs are presented in Appendices E and F. The human health RGOs in Appendix E consider a range of risk and hazard targets consistent with *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001). Appendix F presents a cost-benefit analysis used to select the risk-based target levels and the hot spots to be addressed by the removal action. A summary of the methods consistent with the RAOs is presented in Section 5, "Recommended Removal Action Alternative."

2.4 JUSTIFICATION FOR THE PROPOSED ACTION

NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches have been identified as SWMUs under the PGDP FFA due to the potential for actual or threatened releases of hazardous constituents from the site. Risk evaluations of chemicals and compounds in sediment and surface water at these ditches and outfalls indicate that there is a threat to human health greater than the EPA risk range under some scenarios.

[8] The SWOU SI determined that migration does not result in unacceptable risk; however, addressing hot spots associated with on-site exposure will reduce the potential risks associated with any off-site migration.

3. REMOVAL ACTION TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES

This chapter identifies the applicable representative technologies and alternatives that will be considered for the removal action proposed for NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches. Analyses of the alternatives considered are presented in Section 4.

3.1 TECHNOLOGY IDENTIFICATION AND SCREENING

The alternatives identified and screened in this EE/CA were evaluated based on their ability to meet effectiveness (including RAOs), implementability, and cost. Based on the alternative evaluation, Alternative 4 – "Excavation and Interim Institutional Controls" was chosen as the preferred alternative.

The following alternatives are evaluated in this EE/CA:

1. No control measures (No Action);

2. Interim institutional control measures only;

3. Combination of interim institutional and engineered sediment controls or barriers; and

4. Combination of excavation with sediment control best management practices (BMPs) and interim institutional controls (as needed).

A discussion of these alternatives, including their relative effectiveness, feasibility of implementation, and cost, is provided in the following sections.

3.2 DEVELOPMENT OF ALTERNATIVES

This EE/CA provides a description of the alternatives being considered for reducing human health risk from direct contact with contaminated sediments at NSDD Sections 3, 4, and 5, and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches. The alternatives developed in this EE/CA serve as the basis for the preparation, analysis, and comparison of cost estimates for implementation of the alternatives. The specific methods employed in implementing selected controls, would be defined prior to implementation. The action would be consistent with this EE/CA and the Action Memorandum to be issued following public comment on this EE/CA.

Based on the results of the modeling performed as part of the SWOU SI/BRA report for the outfalls and their associated internal ditches, no contaminants are migrating in surface water (dissolved or through sediment) from ditches to surrounding creeks at concentrations that may adversely impact human health. As a result, sedimentation basins are not considered as an alternative since they would not be a method to meet the RAOs identified in Section 2.3. Additional details for not considering sedimentation basins are included in Appendix C.

3.2.1 No Action Alternative—Alternative 1

Under the No Action Alternative (Alternative 1), there would be no change to the current configuration of the NSDD or to KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches. Requirements for evaluation of the No Action Alternative are presented in EPA guidance for CERCLA response actions (EPA 1999).

3.2.2 Interim Institutional Controls—Alternative 2

Interim institutional controls (Alternative 2) include administrative policies and exclusion or barrier type controls implemented to reduce the risk of exposure to contaminated sediments, prior to selection of the remedial action and pending the selection of additional response actions. Alternative 2 is the implementation of interim institutional controls to reduce the potential of human exposure. These controls include methods of excluding facility personnel and the public from known contamination areas; communicating hazards; monitoring areas for contamination or contaminant mobility; and implementing additional requirements for personal protective equipment (PPE). Interim institutional controls may be either short-term or long-term depending on site characteristics.

The specific type of interim institutional control implemented would be dependent on the specific physical and chemical characteristics of the hazard. For example, contaminated sediments within the NSDD may require different controls than contaminated sediments identified in the internal plant outfall ditches. Interim institutional controls do not completely eliminate issues of contaminant transport, endpoints, or exposure. Removal of contaminated sediments would not occur under Alternative 2, and the risk of human contact with contaminated sediment is reduced, but not completely eliminated. The following are interim institutional controls evaluated under Alternative 2:

- Hazard postings,
- Appropriate PPE requirements,
- Additional radiological survey and other monitoring requirements,
- Fencing,
- Exclusion zones, and
- Long-term environmental monitoring.

Since the risk to human health associated with Sections 3, 4, and 5 of the NSDD and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches is due to direct contact (see Appendix E), the institutional control of exclusion fencing and hazard posting combined with long-term monitoring (i.e., applicable KPDES parameters to monitor whether contaminant migration at levels of concern is occurring) was selected as the alternative for the detailed analysis that is summarized in Section 4, "Analysis of Alternatives."

3.2.3 Combination of Engineering Controls and Interim Institutional Controls—Alternative 3

Engineering controls are systems constructed to capture contaminated sediments, to stabilize or isolate contaminated media, and to limit the mobility of contaminated materials. Engineering controls vary in complexity and cost. The application of controls is dependent on site-specific requirements and design issues. Interim institutional controls may be implemented in combination with engineering controls. In many cases, a combination of interim institutional and engineering controls provides a higher level of protection against environmental releases.

Alternative 3 would implement one or more engineered controls in combination with one or more of the interim institutional controls identified in Alternative 2 to reduce the risk of human exposure to contaminated sediment. During implementation of this alternative, one or more engineered controls would be utilized to capture contaminated soil/sediments, to stabilize or isolate soil/sediments, and/or to limit the mobility of contaminated soil/sediment. Interim institutional controls, such as exclusion zones, fencing, etc., also would be utilized during implementation of Alternative 3. After completion of the alternative action and upon verification that the alternative action objectives were achieved (including site restoration), interim institutional controls designed to prevent exposures during implementation of the removal action would be evaluated and discontinued as appropriate.

The removal of contaminated sediments would not occur under Alternative 3. As a result, the risk of human receptors contacting contaminated sediments would be reduced, but not completely eliminated. The following are the engineered controls evaluated under Alternative 3:

Localized controls—

- Small stormwater retention areas,
- Soil binders or coagulants,
- Encapsulation, and
- Other BMPs including silt fencing, mulching, revegetation, and energy dissipation.

Integrated controls—

- In-line filtration or water treatment,
- Rock check dams,
- Gabions,
- Ditch embankment stabilization,
- Ditch lining/barrier, and
- Sediment traps.

Since the risk to human health associated with Sections 3, 4, and 5 of the NSDD and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches is due to direct contact (see Appendix E), the engineering alternative of ditch lining/barrier combined with exclusion fencing and hazard posting and long-term monitoring (i.e., applicable KPDES parameters to monitor whether contaminant migration at levels of concern is occurring) was selected as the alternative for the detailed analysis that is summarized in Section 4, "Analysis of Alternatives."

3.2.4 Excavation and Interim Institutional Controls—Alternative 4

> **DEFINITION OF A "HOT SPOT" AS USED IN THE SWOU EE/CA**
>
> A "hot spot" is characterized as an area in which the cumulative ELCR from COCs exceeds 1E-05 and/or a cumulative hazard index from COCs exceeds 1.0 under current site conditions. "Hot spots" are depicted in Appendix F, "Risk-Based Cost-Benefit Analysis."

Alternative 4 would implement excavation and removal of "hot spots"[9] that were identified in Section 1.7, "Summary of Risk Assessment," and Appendix E, "Risk Evaluation." During implementation of this alternative, one or more engineered controls to prevent transport of contaminated soils and sediments would be required. Interim institutional controls, such as exclusion zones, fencing, etc., also would be utilized, as needed, during implementation of Alternative 4. After completion of the removal action, and upon verification that the alternative action objectives were achieved (including site restoration), engineering and interim institutional controls would be evaluated and discontinued as appropriate.

[9] A "hot spot" for the SWOU EE/CA is a location where the cumulative ELCR from COCs exceeds 1E-05 and/or a cumulative hazard index from COCs exceeds 1.0 under current site conditions. "Hot spots" are depicted in Appendix F, "Risk-Based Cost-Benefit Analysis."

Unlike Alternatives 1 through 3, Alternative 4 would reduce the risk of exposure to human receptors by removing known sources of contamination. Long-term monitoring and other long-term interim institutional controls may be required after a source is successfully removed and restoration is completed. This alternative assumes a low probability of future contamination discovery in areas where removal actions have occurred.

4. ANALYSIS OF ALTERNATIVES

To determine the relative performance of the proposed technologies, the alternatives discussed in Section 3 were evaluated against three criteria specified by the EPA, including compliance with applicable or relevant and appropriate requirements (ARARs). NEPA values not normally considered in CERCLA documentation also are considered relative to each of the alternatives. Section 4.1 provides a brief description of the evaluation criteria. Analyses of each individual alternative, based on these criteria, are presented in Section 4.2. A comparison of the alternatives is included in Section 4.3.

4.1 ANALYSIS CRITERIA

The EPA *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993) contains three criteria for the evaluation of removal action alternatives. These criteria are effectiveness, implementability, and cost.

Effectiveness evaluates the protectiveness of the removal action and its achievement of the RAOs. Criteria for considering effectiveness include the following:

- RAOs—assess each alternative's ability to meet the project RAOs.

- Overall Protection of Human Health and the Environment—assess how each alternative achieves adequate protection and describe how the alternative would reduce, control, or eliminate risks at the site through treatment, engineering controls, or interim institutional controls.

- Long-Term Effectiveness and Permanence—assess the ability of the alternative technologies to reduce the potential risk posed by the discharge of storm water runoff and sediment. These criteria address the magnitude of residual risks at the site after the removal efforts are complete, the adequacy and reliability of in-place controls, and long-term environmental and cumulative effects.

- Short-Term Effectiveness—assess any threats to site workers and/or recreational users and the effectiveness and reliability of protective measures that would be taken during the removal action.

For implementability, the following three factors were used to assess how realistic a removal alternative is in practice: (1) technical feasibility, (2) administrative feasibility, and (3) resource availability. Criteria for considering implementability include the following:

- Ability to Construct and Operate Technologies—construction and operating complexities are presented. Some operational complexities could include the frequency or complexity of equipment maintenance or controls, the need for raw materials, the need for a large technical staff, and the effects to the environment.

- Availability and Reliability of Technologies—each alternative is evaluated to determine if technologies or services are obtainable, are mature enough to implement, and have been used under similar conditions for similar wastes.

- Availability of Treatment, Storage, and Disposal Services and Capacity—it must be determined whether treatment, storage, and disposal capacity, equipment, personnel, services, materials, and other resources necessary to implement an alternative would be available in time to maintain the removal schedule.

Finally, the alternative is evaluated to determine costs. These are the criteria for considering cost:

- Capital costs—these are comprised of the expenditures associated with construction, equipment and materials, land and building, relocation and transportation, analytical and treatment services, disposal services, engineering and design, legal fees, mobilization and demobilization, and contingencies.

- Operation and Maintenance (O&M)—these costs are comprised of labor and materials to support a routine or defined plan to maintain an institutional control such as performing inspections, replacing signs, repairing fencing, and/or collecting samples for a monitoring program, and preparing reports to document the maintenance has occurred or presenting results of the monitoring sampling.

4.1.1 Applicable or Relevant and Appropriate and To Be Considered Requirements

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, on-site removal actions conducted under CERCLA are required to attain ARARs to the extent practicable, considering the scope and urgency of the action. ARARs involving restoration of surface water are not specifically within the scope of this action; however, these ARARs will be evaluated under subsequent response actions. ARARs include only federal and state environmental or facility siting laws/regulations; they do not include occupational safety or worker radiation protection requirements. Additionally, per 40 *CFR* § 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to be considered (TBC) category].

ARARs typically are divided into three categories: (1) location-specific, (2) chemical-specific, and (3) action-specific. Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., floodplains or historic districts). Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, or air) for specific hazardous substances, pollutants, or contaminants. Action-specific ARARs include operation, performance, and design of the preferred alternative based on waste types and/or media to be addressed, and removal/remedial activities to be implemented.

TBC information also may be used in developing and evaluating removal action alternatives. In the absence of ARARs, TBC information consisting of advisories, criteria, or guidance, such as DOE Orders, may be useful in determining cleanup levels that are protective of human health and the environment. A list of potential ARARs/TBCs has been identified to address the alternatives proposed in this EE/CA and is included as Appendix A.

When DOE proposes a response action, Section XXI of the FFA requires that DOE identify each state and federal permit that otherwise would have been required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan. As documented in Tables A-1, A-2, and A-3 of Appendix A, each ARAR has been evaluated to identify the otherwise required state or federal permits. DOE also must identify the standards, requirements, criteria, or limitations necessary to obtain such permits and provide an explanation of how the proposed action will meet the standards, requirements, criteria, or limitations identified. The evaluation determined that the otherwise required permits may include a KPDES; RCRA Treatment, Storage, and Disposal Facility; and Solid Waste Landfill permits. In addition, a permit from the U.S. Fish and Wildlife Service (USFWS) for "taking" migratory birds may be required. PGDP currently operates under KPDES Permit No. KY0004049, Hazardous Waste Facility Operating Permit No. KY8-890-008-982, and Solid Waste Permit No. 073-00014/073-00015/073-00045, which define the applicable standards, requirements, criteria, or limitations. Upon final selection of an alternative, the USFWS migratory bird list will be reviewed and/or a field survey conducted to determine which species occur or are likely to occur on DOE property and the impact of the alternative on those species. The substantive requirements of the otherwise required permits will be identified in the Environmental Safety & Health section of the Removal Action Work Plan (RAWP).

DOE also determined that if the selected alternative has the potential to impact waters of the United States (including wetlands) and this cannot be avoided, compliance with the substantive TBC requirements of the Nationwide Permits (NWPs) or Kentucky Water Quality Certification discussed herein may be required. Wetlands will be delineated, as necessary, prior to the removal action. Specifically, excavating or backfilling in a water body or wetland and building a temporary or permanent road across a water body or wetland otherwise may require the additional permits and certification such as the following:

- Backfilling an excavation and excavation of hazardous sediments in a water body or in a wetland would require a combination of the following:

    - NWP 38 – Cleanup of Hazardous and Toxic Waste,
    - NWP 18 – Minor Discharges,
    - Water Quality Certification from Kentucky Division of Water.

- Construction of a temporary access road across a water body or wetland would require

    - NWP 33 – Temporary Construction Access.

- Construction of a permanent access road across a water body or wetland would require

    - NWP 14 – Linear Transportation Projects.

Under the NWP program, a prospective permittee must comply with the NWP general conditions, as appropriate, contained in Part II of the March 12, 2007, *Federal Register (FR)* (Volume 72, Number 47). The NWP general conditions that may be TBC requirements for implementation of the selected removal action alternative pertain to, but are not limited to, the following:

- Suitable material
- Fills within 100-year floodplains
- Equipment
- Soil erosion and sediment controls
- Removal of temporary fills
- Proper maintenance
- Wild and scenic rivers
- Endangered species
- Historic properties
- Designated critical resource waters
- Mitigation
- Water quality
- Regional and case-by-case conditions
- Use of multiple NWPs

In addition to the general NWP requirements, specific TBC requirements of NWPs may address any of the following:

- The loss of waters of the United States exceeding 1/10 acre;
- Discharge or the volume of area excavated that exceeds 10 yd^3 below the plane of the ordinary high-water mark or the high-tide line;
- Discharges in a special aquatic site, including wetlands; and
- Requirements for a restoration plan showing how all temporary fills and structures will be removed and the area restored to pre-project conditions.

Applicability of the general and specific standards, requirements, criteria, or limitations of NWPs and the Water Quality Certification will be delineated in the RAWP after final alternative selection. Requirements will be implemented as part of this removal action.

Implementation of the selected alternative will comply with the ARARs/TBCs specified in Appendix A, to the extent practicable. Activities conducted on-site must comply with the substantive but not administrative requirements of ARARs. Administrative requirements include applying for permits, recordkeeping, consultation and reporting. Activities conducted off-site must comply with both the substantive and administrative requirements of applicable laws. Required measures will be incorporated into the design phase and implemented during the construction and operation phases of the removal action. Additional discussion of pertinent ARARs is set forth in Section 4.2 for each alternative, including the No Action Alternative.

4.1.2 NEPA Values

The following NEPA values, not normally addressed by CERCLA documentation, also are considered in this EE/CA to the extent practicable, consistent with DOE policy:

- Land use,
- Air quality and noise,
- Geology and soils,
- Water resources,
- Wetlands and floodplains,
- Ecological resources,
- T&E species,
- Migratory birds;
- Cultural resources, and
- Socioeconomics, including environmental justice and transportation.

The action alternatives analyzed in this EE/CA would have no identified short-term or long-term impacts on geological resources, T&E species, migratory birds, cultural resources, or socioeconomics. Upon final selection of the alternative, the absence of any short- and long-term impacts to these values, including T&E species, migratory birds, and cultural resources, will be verified. Short- or long-term impacts would be managed, to the extent practicable, through compliance with ARARs/TBCs.

No long-term impacts to air quality or noise would result from implementation of any of the action alternatives. Interim institutional controls, engineering controls, and removal actions should not result in generation of air pollutants above regulatory limits, and noise levels should be similar to current background levels.

None of the action alternatives would have any impacts on geology and construction activities would have only short-term impacts on soils. Site clearing, excavation, grading, and contouring would alter the topography of the area where the removal actions are located, but the geologic formations underlying those sites should not be affected. Construction would disturb existing soils, and some topsoil might be removed in the process. Soil erosion impacts during construction would be mitigated through the use of BMP control measures (e.g., covers and silt fences). No conversion of prime farmland soils is expected to occur. Any alternative that would create disturbances also would include restoration to these areas.

Carrying capacity calculations that have been performed indicate that all the drainage ditches will contain the 100-year and 500-year flood discharges associated with Little Bayou Creek and Bayou Creek (COE 1994c). If, during the design phase of a removal action, it is determined that wetlands and/or floodplains would be impacted, compliance with ARARs/TBCs for floodplain/wetlands activities would be followed.

No archaeological or historical resources have been identified within NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches; however, portions of the project may remove soils that previously have been undisturbed and, in accordance with the Cultural Resources Management Plan (BJC 2006), an archaeological survey will be conducted. If archaeological properties are located that will be affected adversely, then appropriate mitigation measures will be employed.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects their activities may have on minority and low-income populations. No census tracts near the site include a higher proportion of minorities than the national average. Some nearby tracts meet the definition of low-income populations, including two tracts to the north-northeast (the direction of the prevailing wind), but these are not the tracts closest to the Paducah site; therefore, there would be no disproportionate or adverse environmental justice impacts to any minority or low-income populations.

No long-term or short-term adverse transportation impacts are expected to result from implementation of action alternatives. During construction activities there would be a slight increase in the volume of truck traffic in the vicinity of the outfalls or the NSDD, but the affected roads are capable of handling the additional truck traffic.

Additional discussion of pertinent NEPA values is set forth in Section 4.2 for each alternative, including the No Action Alternative.

4.2 ANALYSIS OF INDIVIDUAL ALTERNATIVES

Analysis of each alternative is provided in the following sections.

4.2.1 Alternative 1—No Action Alternative

The No Action Alternative is considered the least protective of the alternatives presented in Section 3. Because none of the EE/CA RAOs are achieved by implementation of the No Action Alternative, it is considered the least effective of all of the alternatives presented.

4.2.1.1 Effectiveness

The No Action alternative would be ineffective in meeting any of the RAOs stated in Section 2. The alternative would not provide for overall protection of human health or the environment because the potential for on-site worker and recreational user contact with contaminated sediments would not be remedied. Comparison to the effectiveness criteria follows.

- <u>RAOs</u>—The alternative does not achieve any of the project RAOs.

- <u>Overall Protection of Human Health and the Environment</u>—The alternative does not provide for protection of human health and the environment since no action is taken. As a result, the alternative is not protective.

- <u>Long-Term Effectiveness and Permanence</u>—The alternative has no long-term effectiveness.

- <u>Short-Term Effectiveness</u>—The alternative does not provide for short-term control measures to protect industrial workers or recreational users.

- <u>Compliance with ARARs</u>—This is discussed in Section 4.2.1.4.

There is no overall effectiveness rating of the No Action Alternative.

4.2.1.2 Implementability

The No Action alternative ranks high in ease of implementation since implementation requires no further resources, and technical feasibility is not a consideration. Because of DOE policy and state and federal law, however, the No Action Alternative is not considered to be administratively feasible.

4.2.1.3 Cost

There would be no cost for implementing the No Action Alternative.

4.2.1.4 Compliance with ARARs

The No Action Alternative would not comply with ARARs.

4.2.1.5 NEPA Values

Under the No Action Alternative short- and long-term impacts may occur to the following NEPA values identified in Section 4.1.

- Soils
- Water resources
- Ecological resources

Soils in the outfalls and their associated ditches and along the NSDD may be impacted as contaminated sediments are redistributed from "hot spots" by surface water runoff into areas previously uncontaminated. Similarly, water resources may be impacted as contaminants are mobilized by surface water runoff. Ecological resources in the NSDD may be impacted as terrestrial and aquatic biota is exposed to contaminated media.

4.2.2 Alternative 2—Interim Institutional Controls

The interim institutional controls identified for analysis under this EE/CA are exclusion fencing and hazard posting in combination with long-term monitoring (i.e., applicable KPDES parameters to monitor whether contaminant migration at levels of concern is occurring). Fencing is a control intended to exclude unauthorized personnel from entry into the "hot spot" area. Hazard postings are intended to warn site workers or recreational users of the hazard and provide direction, should access to the area be required. In the case of routine maintenance activities, additional contingency controls such as PPE, radiological surveying, or environmental monitoring may be required as short-term institutional controls while the maintenance activity is being performed. Long-term effluent monitoring for applicable KPDES parameters will be performed to monitor whether contaminant migration is occurring at levels of concern.

4.2.2.1 Effectiveness

Implementation of interim institutional controls would achieve the RAOs identified in Section 2.3. Implementation of interim institutional controls would decrease the risk of human exposure through exclusion or other institutional means. Interim institutional controls alone, however, would not control contaminant sources nor would they control the potential for contaminant migration. Additionally, interim institutional controls would not prevent entry by those who do not adhere to the control (e.g., the intentional trespasser). A discussion of the alternative effectiveness criteria follows.

- RAOs—The alternative achieves all the project RAOs

- Overall Protection of Human Health and the Environment—The alternative provides for protection of human health by controlling access to the contamination, but does not remove the contamination. As a result, this alternative is rated moderate.

- Long-Term Effectiveness and Permanence—The alternative has limited long-term effectiveness since it does not remove contamination. As a result, this alternative is rated low.

- Short-Term Effectiveness—The alternative provides for limited short-term control measures to protect industrial workers and/or recreational users and its effectiveness therefore is considered moderate.

- Compliance with ARARs—This is discussed in Section 4.2.2.4.

The overall effectiveness rating of Alternative 2 is low to moderate.

4.2.2.2 Implementability

Alternative 2 would require a relatively low effort to implement. The interim institutional controls identified in this section can be rapidly implemented with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings. Long-term monitoring would require more effort to implement. Plans (SAPs, site-specific health and safety plans, O&M plans, etc.) would need to be prepared and approved. Additional personnel and training may be required. The following discussion evaluates the implementability criteria for Alternative 2.

- Ability to Construct and Operate Technologies—The resources required to implement interim institutional controls such as fencing and hazard postings are considered minimal. There would be a slight increase in demands on staff for inspection and maintenance activities and long-term monitoring; there would be minimal needs for raw materials; implementation of controls would not require complex operating technologies; and the effects to the environment due to alternative implementation would be minimal. The ranking for this criterion is high.

- Availability and Reliability of Technologies—The technology is proven and readily available to implement interim institutional controls. The ranking for this criterion is high.

- Availability of Treatment, Storage, and Disposal Services and Capacity—This alternative does not require treatment, storage, or disposal services, and the criterion does not apply.

The overall implementability ranking of Alternative 2 is high.

4.2.2.3 Cost

The estimated capital cost for the various interim institutional controls associated with Alternative 2 is $565,904, with an additional estimated O&M cost of $558,676 (see Appendix B, Table B.1). Because the costs are low relative to other alternatives, the cost ranking for Alternative 2 is high.

4.2.2.4 Compliance with ARARs

Implementation of interim institutional controls would comply to the extent practicable with ARARs, as detailed in Appendix A.

4.2.2.5 NEPA Values

Similar to the No Action Alternative, short- and long-term impacts may occur to the following NEPA values identified in Section 4.1 by implementation of Alternative 2.

- Soils
- Water resources
- Ecological resources

Soils in the outfalls and their associated ditches and along the NSDD may be impacted as contaminated sediments are redistributed from "hot spots" by surface water runoff into areas previously uncontaminated. Similarly, water resources may be impacted as contaminants are mobilized by surface water runoff. Ecological resources in the NSDD may be impacted as terrestrial and aquatic biota are exposed to contaminated media.

These impacts to NEPA values may occur because interim institutional controls alone will not remove contaminated sediments from the environment.

4.2.3 Alternative 3—Combination of Engineering and Interim Institutional Controls

The combination of engineering controls and interim institutional controls identified for analysis under this EE/CA are the application of an impermeable high-density polyethylene (HDPE) liner/barrier, coupled with exclusion fencing and hazard posting and long-term monitoring (i.e., applicable KPDES parameters to monitor whether contaminant migration at levels of concern is occurring). Installation of impermeable HDPE liner/barrier in the "hot spot" area will reduce the risk of human receptors contacting contaminated sediments and minimize sediment migration. Fencing is a control intended to exclude unauthorized personnel from entry into the "hot spot" area, further reducing the potential for direct contact with contaminated sediment. Hazard postings are intended to warn site workers or recreational users of the hazard and provide direction should access to the area be required. During installation of the engineering control, additional contingency controls such as small stormwater retention areas and silt fencing may be temporarily required as localized engineering controls while the impermeable HDPE liner/barrier is being installed. Installation of these temporary controls is dependent upon the site conditions at the time of installation. After installation of the impermeable HDPE liner/barrier is complete, and upon verification that the alternative action objectives were achieved (including site restoration), localized engineering controls would be evaluated and discontinued as appropriate. In the case of routine maintenance activities, a different set of contingency controls such as PPE, radiological surveying, or environmental monitoring may be required as short-term institutional controls while the maintenance activity is being performed. Long-term effluent monitoring for applicable KPDES parameters will be performed to monitor whether contaminant migration is occurring at levels of concern.

4.2.3.1 Effectiveness

Implementation of the impermeable HDPE liner/barrier, in combination with exclusion fencing and hazard posting and long-term monitoring (i.e., applicable KPDES parameters to monitor whether contaminant migration is occurring at levels of concern), would achieve the RAOs identified in Section 2.3. This alternative provides for an enhanced level of protectiveness for industrial workers and recreational users. The RAOs are satisfied by this alternative. Combining engineered controls with interim institutional controls places additional physical barriers between contamination and contaminant receptors. Similar to Alternative 2, contaminated sediments would not be removed from the environment by Alternative 3. Alternative 3 is protective of industrial workers and recreational users; however, the engineering controls are subject to the limits of their design life, and interim institutional controls would not prevent entry by those who fail to adhere to the control (e.g., the intentional trespasser). A discussion of the alternative effectiveness criteria follows.

- RAOs—The alternative achieves all the project RAOs.

- Overall Protection of Human Health and the Environment—The alternative provides for protection of human health by controlling access to the contamination, but does not remove the contamination. As a result, this alternative is rated moderate.

- Long-Term Effectiveness and Permanence—The alternative has limited long-term effectiveness since it does not remove contamination and liners have a limited service life. As a result, this alternative is rated moderate.

- Short-Term Effectiveness—The alternative provides for short-term control measures to protect industrial workers and/or recreational users and its effectiveness therefore is considered high.

- Compliance with ARARs—This is discussed in Section 4.2.3.4.

The overall effectiveness rating of Alternative 3 is moderate.

4.2.3.2 Implementability

Alternative 3 would require a level of implementation effort greater than the previous alternatives (Alternatives 1 and 2). Installation of HDPE barrier will require engineering plans, specifications, bid packages, and other documents. The interim institutional controls identified in this section can be rapidly implemented with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings. Long-term monitoring would require more effort to implement. Plans (SAPs, site-specific health and safety plans, O&M plans, etc.) would need to be prepared and approved. Additional personnel and training may be required. The following discussion evaluates the implementability criteria for Alternative 3.

- Ability to Construct and Operate Technologies—The resources required for the installation of impermeable HDPE liner/barrier are considered significant. There would be an increase in demands on engineering and scientific staff for the design and development of engineering plans, specifications, bid packages, and other documents. Raw material needs typically would be moderate. Operating technologies for most sediment and stormwater engineering controls are not complex and may be implemented with a minimal amount of engineering and hydrologic analysis. Environmental impacts due to alternative implementation typically would be minor. The resources required to construct interim institutional controls such as fencing and hazard postings also are considered minimal. There would be a slight increase in demands on staff for inspection and maintenance activities and long-term monitoring; there would be minimal needs for raw materials; implementation of controls would not require complex operating technologies; and the effects to the environment would be minimal due to alternative implementation. The ranking for this criterion is high.

- Availability and Reliability of Technologies—The technology is proven and readily available to implement installation of impermeable HDPE liner/barrier and interim institutional controls. The ranking for this criterion is high.

- Availability of Treatment, Storage, and Disposal Services and Capacity—Some of the controls associated with this alternative would require treatment, storage, or disposal services. It is expected that these services would be provided by existing PGDP facilities or off-site facilities. The ranking for this criterion is high.

The overall implementability ranking of Alternative 3 is high.

4.2.3.3 Cost

The estimated capital cost for the various engineering and interim institutional controls associated with Alternative 3 is $2,825,186, with an additional estimated O&M cost of $562,576 (see Appendix B, Table B.1). The cost ranking for Alternative 3 is moderate to high.

4.2.3.4 Compliance with ARARs

Implementation of engineering and interim institutional controls would comply to the extent practicable with ARARs, as listed in Appendix A.

Impacts to wetlands, critical habitat, migratory birds, floodplains, streams, and/or aquatic habitat would be determined during the design phase of the engineering control. Required measures for compliance with ARARs/TBCs to the extent practicable would be incorporated into the design phase and implemented during the construction and operation phases of the engineering controls.

The engineering controls identified in this EE/CA would require heavy construction. Compliance with the applicable action-specific ARARs/TBCs would be followed to the extent practicable. Required measures would be incorporated into the design phase and implemented during the construction and operation phases of the engineering controls. For example, construction activities would be conducted in a manner that would limit fugitive dust emissions and would provide sedimentation controls, thereby limiting potential impacts due to airborne particulates and suspended solid loading.

4.2.3.5 NEPA Values

Short- and long-term impacts may occur to the following NEPA values identified in Section 4.1 by implementation of Alternative 3.

- Land use
- Air quality and noise
- Wetlands and floodplains
- Soils
- Water resources
- Ecological resources

Land use potentially may be restricted in certain areas in and around the PGDP as contaminated areas are identified. Alternative 3 would limit the potential for contaminant mobility and limit human contact. If contaminated sediments are mobilized, land use in those areas also may be restricted. Potential restrictions may include building or other infrastructure restrictions and restricting certain outdoor activities such as hunting in portions of the Bayou and Little Bayou drainages.

The engineering control identified in this EE/CA would require heavy construction. There would be minor short-term impacts to air quality and noise resulting from Alternative 3 during construction activities. Air quality impacts would include emissions from vehicle and equipment exhaust and fugitive dust from vehicle traffic and disturbance of soils. Site preparation and construction activities would be short-term, sporadic, and localized (except for emissions from vehicles of construction workers and transport of construction materials and equipment). Fugitive dust from excavation and earthwork activities would be noticeable on-site and in the immediate vicinity. Dispersion would decrease concentrations of pollutants in the ambient air as distance from the construction site increased. The use of control measures (i.e., covers and water or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary National Ambient Air Quality Standards (NAAQS) would be expected.

Increased noise levels from the transport and use of construction equipment in the immediate vicinity of construction also would be short-term, sporadic, and localized. Noise levels already are slightly elevated in the vicinity of the PGDP outfalls because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near the NSDD Sections 3, 4, and 5 and the outfalls; thus, no noise impacts would occur. Construction or operational activities including excavation, dredging, or road building may impact wetlands or regulatory floodways. If, during the design phase of the removal action, it is determined that wetlands and/or floodplains would be impacted, ARARs/TBCs requirements for floodplain/wetlands would be implemented to the extent practicable and mitigate short- or long-term impacts.

Implementation of Alternative 3 would limit contaminant mobility, but not necessarily eliminate the potential for contaminant transport or the risk of short- and long-term impacts to soils, water resources, and ecological resources. If contaminated sediments are mobilized during implementation of Alternative 3, soils in and around the PGDP may be impacted as contaminated sediments are transported by surface water runoff into areas previously uncontaminated. Similarly, water resources may be impacted as contaminants are mobilized by surface water runoff and transported to Bayou Creek and Little Bayou Creek. Ecological resources in the Bayou and Little Bayou drainages may be impacted as terrestrial and aquatic biota are exposed to contaminated media.

These short- and long-term impacts to NEPA values may occur because engineering and interim institutional controls alone will not remove hazardous materials from the environment, and contaminant transport mechanism controls may not be 100% effective.

4.2.4 Alternative 4—Excavation and Interim Institutional Controls

Alternative 4 would excavate "hot spots" that were identified in Section 1.7, "Summary of Risk Assessment," and implement exclusion fencing and hazard postings, as needed, to minimize direct contact with contaminated sediment and soil. Excavation of the top 2 ft of soil/sediment from the "hot spot" area will eliminate the risk of human receptors contacting contaminated sediments. Fencing is a control intended to exclude unauthorized personnel from entry into the "hot spot" area and will adequately manage future risk of residual contamination. Hazard postings are intended to warn site workers or recreational users of the hazard and provide direction should access to the area be required. During excavation activities, additional contingency controls such as small stormwater retention areas, silt fencing, or rock check dams may be temporarily required as localized engineering controls. Installation of these temporary controls is dependent upon the site conditions at the time of excavation. After excavation of the "hot spot" area is complete samples would be collected for verification purposes. Upon verification that the alternative action objectives were achieved (including site restoration), localized engineering controls would be evaluated and discontinued, as appropriate. In the case of routine maintenance activities, a different set of contingency controls such as PPE, radiological surveying, or environmental monitoring may be required as short-term institutional controls while the maintenance activity is being performed. Because the "hot spot" will be removed, no long-term effluent monitoring for contaminant migration will be required.

4.2.4.1 Effectiveness

Implementation of excavation in combination with exclusion fencing and hazard posting outlined in Alternative 4 would achieve all of the RAOs identified in Section 2.3. This alternative provides for a complete level of protectiveness for industrial workers and recreational users. The RAOs are satisfied by this alternative. The combination of excavation with interim institutional controls, as needed, not only removes the contamination, but also adequately manages current and future risk associated with potential direct contact to any residual contamination. Under Alternative 4, "hot spot" areas would be removed from the environment. The risk to industrial workers and recreational users from direct contact with soil/sediment would be permanently reduced and "hot spots" would be permanently eliminated. A discussion of the alternative effectiveness criteria follows.

- <u>RAOs</u>—The alternative achieves all the project RAOs.

- <u>Overall Protection of Human Health and the Environment</u>—The alternative provides for a high level of overall protection of human health and the environment since the "hot spot" is removed. As a result, this alternative is rated high.

- <u>Long-Term Effectiveness and Permanence</u>—The alternative has high long-term effectiveness and permanent solutions since the "hot spot" is removed. As a result, this alternative is rated high.

- <u>Short-Term Effectiveness</u>—The alternative provides for short-term control measures to protect industrial workers and recreational users and its effectiveness therefore is considered high.

- <u>Compliance with ARARs</u>—This is discussed in Section 4.2.4.4.

The overall effectiveness rating of Alternative 4 is high.

4.2.4.2 Implementability

Alternative 4 would require a level of implementation effort greater than the previous alternatives (Alternatives 1, 2, and 3). Excavation of the top 2 ft of soil/sediment from the “hot spot” area will require engineering plans, specifications, bid packages, and other documents. The interim institutional controls identified in this section can be implemented rapidly with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings, as needed, to minimize direct contact with contaminated sediment and soil. Additional personnel and training may be required. The following discussion evaluates the implementability criteria for Alternative 4.

- Ability to Construct and Operate Technologies—The resources required to implement excavation of the top 2 ft of soil/sediment from the “hot spot” area are readily available and the provision of construction support is available locally. There would be an increase in demands on engineering and scientific staff for the design and development of engineering plans, specifications, bid packages, and other documents. Environmental impacts due to alternative implementation typically would be minor. The resources required to implement interim institutional controls such as fencing and hazard postings also are considered minimal. There would be a slight increase in demands on staff for inspection and maintenance activities and long-term monitoring; there would be minimal needs for raw materials; implementation of controls would not require complex operating technologies; and the effects to the environment due to alternative implementation would be minimal. The ranking for this criterion is high.

- Availability and Reliability of Technologies—The technology is proven and readily available to implement excavation activities and interim institutional controls. The ranking for this criterion is high.

- Availability of Treatment, Storage, and Disposal Services and Capacity—Excavation activities would require treatment, storage, and disposal services. It is expected that these services would be provided by existing PGDP facilities or off-site facilities. The ranking for this criterion is moderate.

The overall implementability ranking of Alternative 4 is high.

4.2.4.3 Cost

The estimated capital cost for the excavation and interim institutional controls (as needed) associated with Alternative 4 is $7,630,816, with an additional estimated O&M cost of $5,000 (see Appendix B, Table B.1). Because the costs are comparable to implementation of complex engineering controls, the cost ranking for Alternative 4 is moderate to high.

4.2.4.4 Compliance with ARARs

Implementation of Alternative 4 would comply to the extent practicable with ARARs, as listed in Appendix A.

Impacts to wetlands, critical habitat, migratory birds, floodplains, streams, and/or aquatic habitat would be determined during the design phase of an excavation and removal of contaminated soil/sediment. Required measures for compliance with the location-specific ARARs/TBCs to the extent practicable would be incorporated into the design phase and implemented during the construction and operation phases of the excavation and removal action. For example, the only sensitive resource located in close proximity to the removal areas is the nesting habitat for the Indiana bat. During the nesting season (spring and summer), the Indiana bat may inhabit deciduous trees with greater than a 3 inch diameter at breast height (dbh). If this critical habitat cannot be protected through avoidance (e.g., by not cutting trees larger than 3 inches dbh) during spring and summer, the lost habitat will be replaced to ensure no net loss or adverse modification of the resource.

All action-specific ARARs/TBCs listed in Appendix A are applicable for the implementation of Alternative 4. Compliance with ARARs/TBCs would be followed to the extent practicable. Required measures that will be incorporated into the design phase and implemented during the construction and operation phases of Alternative 4 include, but are not limited to, the following:

- Excavation and removal activities will be conducted in a manner that will limit fugitive dust emissions and will provide sedimentation controls, thereby limiting potential impacts due to airborne particulates and suspended solid loading.

- Soil and other waste materials generated as a result of this excavation and removal of contaminated media will be characterized properly and disposed of in accordance with the substantive provisions of ARARs/TBCs in Appendix A for low-level hazardous and PCB waste. All on-site management of such materials also will be conducted in accordance with the substantive provisions of ARARs/TBCs. In the preamble to the *FR* Notice for the 1998 PCB Disposal Amendment, EPA discussed the applicability of 40 *CFR* § 761.61, which provides cleanup and disposal options for PCB remediation waste, as an applicable ARAR and stated: "EPA anticipates that today's rule will be a potential ARAR at CERCLA sites where PCBs are present. EPA would expect that CERCLA cleanups typically would comply with the substantive requirements of one of the three options [self-implementing, performance-based or risk-based] provided by 761.61, upon completion of the cleanups. This decision would not be made by the facility, but in the remedy selection process" 63 *FR* 35407 (June 29, 1998).

- DOE will perform disposal [in accordance with 40 *CFR* § 761.61(a)(5)(v)] of soil containing equal to or less than 49 ppm PCBs at the C-746-U solid waste landfill. The Environmental Performance Standard in 401 Kentucky Administrative Regulations (*KAR*) 47:030, Section 8, and Condition Number T-66 of Solid Waste Permit No. 073-00014/073-00015/073-00045 currently allow such disposal. Compliance with the performance standard and solid waste permit condition will not pose an unreasonable risk of injury to human health or the environment. PCB-contaminated soil requiring off-site disposal (greater than 49 ppm) will be disposed at Energy*Solutions* in Clive, Utah, under their current coordinated approval in accordance with 40 *CFR* § 761.61(b). An alternate facility (facilities) for disposal of PCB remediation waste may be used if the receiving facility is a performance based facility under 40 *CFR* § 761.61(b) or under DOE risk-based disposal as allowed in 40 *CFR* § 761.61(c).

- Any wastes transferred off-site or transported in commerce along public rights-of-way must meet the requirements summarized in Appendix A, depending on the type of waste (e.g., RCRA, PCB, or low-level waste). These include packaging, labeling, marking, manifesting, and placarding requirements for hazardous materials at 49 *CFR* Parts 170–180 *et seq*. However, transport of wastes along roads within the PGDP site that are not accessible to the public would not be considered "in commerce."

- In addition, CERCLA Section 121(d)(3) provides that off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that complies with applicable federal and state laws and has been approved by the EPA for acceptance of CERCLA waste (see also the "Off-Site Rule" at 40 *CFR* § 300.440 *et seq*.). Accordingly, DOE will verify with the appropriate EPA regional contact that any proposed off-site facility is acceptable for receipt of CERCLA wastes before transfer.

4.2.4.5 NEPA Values

No long-term and minor short-term impacts to land use would occur under Alternative 4. Land surrounding NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches is designated as industrial within the DOE "buffer zone" with the exception of NSDD. Land use of the immediate area surrounding the outfalls currently is governed by interim institutional controls that restrict access to these areas. It is assumed that these controls would remain in place under Alternative 4; thus, land use would remain unchanged.

Short-term impacts may occur to the following NEPA values identified in Section 4.1 by implementation of Alternative 4:

- Air quality and noise
- Wetlands and floodplains
- Soils
- Water resources
- Ecological resources

Excavation activities would require heavy construction. There would be minor short-term impacts to air quality and noise resulting from Alternative 4 during construction activities. Air quality impacts would include emissions from vehicle and equipment exhaust and fugitive dust from vehicle traffic and disturbance of soils. Site preparation and construction activities would be short-term, sporadic, and localized (except for emissions from vehicles of construction workers and transport of construction materials and equipment). Fugitive dust from excavation and earthwork activities would be noticeable on-site and in the immediate vicinity. Dispersion would decrease concentrations of pollutants in the ambient air as distance from the construction site increased. The use of control measures (i.e., covers and water or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary NAAQS would be expected.

Increased noise levels from the transport and use of construction equipment in the immediate vicinity of construction also would be short-term, sporadic, and localized. Noise levels already are slightly elevated in the vicinity of the PGDP outfalls because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near the NSDD Sections 3, 4, and 5 and the outfalls; thus, no noise impacts would occur. Construction or operational activities including excavation, dredging, or road building may impact wetlands or regulatory floodways. If, during the design phase of the removal action, it is determined that wetlands and/or floodplains would be impacted, ARARs/TBCs requirements for floodplain/wetlands would be implemented to the extent practicable and mitigate short- or long-term impacts.

Alternative 4 would have short-term impacts on soils. Site clearing, excavation, grading, and contouring would alter the topography of the area where the removal actions are located, but the geologic formations underlying those sites should not be affected. Construction would disturb existing soils, and some topsoil might be removed in the process. Soil erosion impacts during construction would be mitigated through the use of control measures (e.g., covers and silt fences). No conversion of prime farmland soils is expected to occur. Site restoration would be performed at the conclusion of this alternative to minimize the impacts to the areas disturbed during implementation.

Short-term impacts to water resources may result from localized construction activity. These impacts typically would occur in the form of stormwater runoff from the construction site resulting in elevated levels of suspended solids. Silt fencing and other construction BMPs would be used to minimize short-term impacts to water quality.

Short-term negative impacts to ecological resources are likely to occur during construction activities associated with Alternative 4. The existing vegetation that provides habitat and food to plants and animals would be eliminated in the vicinity of the work site. Site preparation activities and excavation also could cause the direct loss of some less mobile wildlife located at the construction site, while other wildlife could be displaced from the cleared areas. The degree of these potential impacts would increase with the surface area removed. Due to the isolated and fragmented nature of the existing habitat, impacts would tend to be major to localized indigenous species that have a small home range or are nonmobile. Some species are specifically adapted to the type of habitat surrounding the outfalls. By removing the habitat, some populations may be heavily impacted, but overall, the species as a whole likely would be unaffected.

4.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The following sections present a comparison of the proposed removal action alternatives based on effectiveness, implementability, and cost criteria. A summary of the alternative comparisons is shown in Table 1.

4.3.1 Effectiveness

Alternative 1, the No-Action Alternative is considered the least protective of all of the alternatives considered. Alternative 1 does not meet project RAOs, nor does it provide for overall protection of human health and the environment. Direct contact risk at the NSDD and on-site ditches is not eliminated or controlled by Alternative 1. There is no overall effectiveness associated with Alternative 1.

Alternative 2 provides for limited protection against direct contact with “hot spots” for industrial workers and recreational users. The RAOs are satisfied by this alternative. Implementation of interim institutional controls would decrease the risk of human exposure through exclusion or other institutional means. Interim institutional controls alone would not control contaminant sources, nor would they control the potential for contaminant migration, since the contaminated sediments are not removed. Interim institutional controls would not prevent entry by those who do not adhere to the control (e.g., the intentional trespasser). The effectiveness of Alternative 2 is ranked as low to moderate.

Alternative 3 provides for an enhanced level of protectiveness to industrial workers and recreational users. The RAOs are satisfied by this alternative. Combining engineered controls with interim institutional controls may place additional physical barriers between contamination and contaminant receptors. Similar to Alternative 2, contaminated sediments would not be removed from the environment by Alternative 3. Under Alternative 3, barriers are subject to the limits of their design life, and interim institutional controls would not prevent entry by those that do not adhere to the control (e.g., the intentional trespasser). The effectiveness of Alternative 3 is ranked moderate.

Alternative 4 provides for excavation of “hot spots” from the NSDD and outfall ditches and associated areas. This alternative provides for a complete level of protectiveness for industrial workers and recreational users. The RAOs are satisfied by this alternative. The combination of excavation with interim institutional controls not only removes the contamination, but also adequately manages current and future risk associated with potential direct contact to any residual contamination. Under Alternative 4, “hot spot” areas would be removed from the environment. The risk to industrial workers and recreational users from direct contact with soil/sediment would be permanently reduced, and “hot spots” would be permanently eliminated. All project RAOs are achieved by this alternative, and its effectiveness is ranked high.

Table 1. Alternative Summary Comparisons

Criteria	Alternative 1. No Action Alternative	Alternative 2. Interim Institutional Controls	Alternative 3. Combination of Interim Institutional and Engineering Controls	Alternative 4. Combination of Excavation and Interim Institutional Controls
Effectiveness				
RAOs	Does not meet RAOs.	Meets RAOs.	Meets RAOs.	Meets RAOs.
Overall Protection of Human Health and the Environment	Not protective.	Moderate.	Moderate.	High.
Long-term Effectiveness and Permanence	Not effective.	Low.	Moderate.	High.
Short-term Effectiveness	No short-term effectiveness.	Moderate.	High.	High.
Overall Effectiveness	None.	Low to Moderate.	Moderate.	High.

Table 1. Alternative Summary Comparisons (Continued)

Criteria	Alternative 1. No Action Alternative	Alternative 2. Interim Institutional Controls	Alternative 3. Combination of Interim Institutional and Engineering Controls	Alternative 4. Combination of Excavation and Interim Institutional Controls
Implementability				
Ability to Construct and Operate Technologies	Not applicable.	High. Minimal construction and operating effort.	High. Standard construction techniques and minimal operator effort.	High. Standard construction techniques and minimal operator effort.
Availability and Reliability of Technologies	Not applicable.	High. Technology is readily available.	High. Technology is readily available.	High. Technology is readily available.
Availability of Treatment, Storage, and Disposal Services and Capacity	Not applicable.	Not applicable.	High. May require minimal waste storage and disposal.	Moderate. Will require waste storage and disposal.
Overall Implementability	Not applicable.	High. Easily implemented.	High. Easily implemented.	High. Easily implemented.
Cost				
Capital Cost	Not applicable.	$565,904	$2,825,186	$7,630,816
O&M Cost	Not applicable.	$558,676	$562,576	$5,000
Present Value Total Cost with 30-year O&M	Not applicable.	$17,326,184	$19,702,466	$7,780,816
Escalated Total Cost with 30-year O&M	Not applicable.	$27,150,171	$29,760,323	$8,310,533

RAO = Removal Action Objective

4.3.2 Implementability

Alternative 1, the No Action alternative ranks high in ease of implementation since implementation requires no further resources and technical feasibility is not a consideration. Because of DOE policy and state and federal law, however, the No Action Alternative is not considered to be administratively feasible.

Alternative 2 would require a relatively low effort to implement. The interim institutional controls identified in this section can be rapidly implemented with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings. Long-term monitoring would require more effort to implement. Plans (SAPs, site-specific health and safety plans, O&M plans, etc.) would need to be prepared and approved. Additional personnel and training may be required.

Alternative 3 would require a level of implementation effort greater than the previous alternatives (Alternatives 1 and 2). Installation of HDPE barrier will required engineering plans, specifications, bid packages, and other documents. The interim institutional controls identified in this section can be rapidly implemented with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings. Long-term monitoring would require more effort to implement. Plans (SAPs, site-specific health and safety plans, O&M plans, etc.) would need to be prepared and approved. Additional personnel and training may be required.

Alternative 4 would require a level of implementation effort greater than the previous alternatives (Alternatives 1, 2, and 3). Excavation of the top 2 ft of soil/sediment from the “hot spot” area will require engineering plans, specifications, bid packages, and other documents. The interim institutional controls identified in this section can be rapidly implemented with a minimum amount of planning or supporting work. These controls include installation of exclusion fencing and hazard postings, as needed, to minimize direct contact with contaminated sediment and soil. Additional personnel and training may be required.

4.3.3 Cost

Estimated action alternative costs are presented in Appendix B, Tables B.1 through B.3. In order to estimate and compare the relative magnitude of cost for each action alternative, assumptions were made regarding the types of controls implemented, the amount of long-term monitoring and O&M required, and the quantities of waste removed. All alternatives assume a 30-year design life. These assumptions for the cost model are presented below.

Alternative 2. Institutional control measures only.

- Installation of exclusion fencing and hazard posting around “hot spots” covering a total of 3.6 acres.
- Inspection and maintenance of fencing and hazard postings.
- Long-term effluent monitoring for applicable KPDES parameters to ensure that contaminant migration does not occur.

Alternative 3. Combination of institutional and engineered sediment controls or barriers.

- Installation of impermeable HDPE liner/barrier in “hot spots” covering a total of 3.6 acres.

- Installation of exclusion fencing and hazard posting for around “hot spots” covering a total of 3.6 acres.

- Inspection and maintenance of fencing and hazard postings.

- Long-term monitoring for applicable KPDES parameters to ensure that contaminant migration does not occur.

Alternative 4. Combination of removal action (excavation) with sediment control BMPs and interim institutional controls (as needed).

- Excavation and disposal of the top 2 ft of soil/sediment from “hot spots” covering a total of 3.6 acres.
- Restoration (i.e., backfill with clean soil, reseeding, etc.) of disturbed acreage.
- Engineered sediment controls and temporary fencing during implementation (BMPs).
- Verification sampling during excavation.
- Continued inspection and site maintenance during and after excavation and restorations.
- No long-term effluent monitoring for contaminant migration.

As shown in the accompanying economic analysis, the initial capital investment (capital cost) is most expensive for Alternative 4 and least expensive for Alternative 2. The economic analysis shows that over the 30-year design life of the alternatives, Alternative 4 is least expensive based on the combination of long-term O&M and the initial capital investment (capital cost). This variance is due to the cost of long-term monitoring and maintenance of both institutional and engineering controls.

If it is determined through the CERCLA review process that the proposed final cleanup levels presented in Section 5, “Recommended Removal Action Alternative,” require modification, then the impacts to the “hot spot” acreage will need to be reevaluated to determine if the selected alternative is still correct. The cost associated with excavation and disposal is most significantly impacted by “hot spot” acreage.

5. RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the comparative analysis, Alternative 4 - "Excavation and Interim Institutional Controls" is the recommended removal action alternative. The evaluation included consideration of effectiveness, implementability, cost, and whether the alternative meets RAOs. The major components of the recommended removal action alternative consist of the following.

- Excavation of hot spots depicted in maps in Appendix F, Attachment F1 to a depth of 2 ft.
- Hot spots were identified using a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 based upon the information presented in Appendix F, "Risk-Based Cost-Benefit Analysis."
- Collection of samples from the bottom of the hot spot to confirm that the risk-based targets of a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 have been achieved.
- Consistent with the results of the risk-based cost-benefit analysis, verification of cleanup to the cumulative ELCR of 1E-05 following excavation will be based upon comparisons between sampling results and chemical-specific ELCR-based cleanup levels. The ELCR target used in deriving the cleanup levels will be 5E-06. Examples of cancer risk-based cleanup levels that will be used in the comparison for the SWOU On-Site Project are shown below.

COC	ELCR-based Cleanup Levels
Total PCB	16 mg/kg
Thorium-230	150 pCi/g

- Consistent with the results of the risk-based cost-benefit analysis, verification of cleanup to the cumulative HI of 1.0 following excavation will be based upon comparisons between sampling results and chemical-specific HI-based cleanup levels. The HI target used in deriving the cleanup levels will be 1.0. An example of an HI-based cleanup level that will be used in the comparison for the SWOU On-Site Project is shown below.

COC	HI-based Cleanup Levels
Uranium	227 mg/kg

- If the alternative is selected, methods to validate the achievement of the chemical-specific cleanup levels will be implemented similar to the NSDD Sections 1 and 2 remediation. Specific details will be scoped by the project team and will be presented in the RAWP.

In accordance with 40 *CFR* § 761.61, there are three potential approaches for identifying cleanup levels for PCBs. They are 1) self-implementing, 2) performance-based, and 3) risk-based. The approach that is being used for this cleanup activity is risk-based, consistent with

NSDD SECTIONS 1 AND 2 REMEDIATION IMPLEMENTATION STRATEGY

The NSDD Sections 1 and 2 excavation strategy assumed an initial excavation to the depth of 4 ft bgs, followed by the collection of soil samples from the bottom of the excavation. If sampling indicated the presence of excess levels of residual contamination, DOE reviewed the data and consulted with the regulatory agencies [*Remedial Design/Remedial Action Work Plan for the North-South Diversion Ditch Sections 1 and 2 Remediation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2054&D2)].

40 *CFR* § 761.61 (c). Under this approach, the PCB cleanup level for this interim cleanup action will achieve a cumulative ELCR of 1E-05 (See Appendix F). The risk-based option has been selected to account for site-specific exposure scenarios and the presence of other contaminants.

Implementation of the selected alternative will reduce risk to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 in the hot spots under current site conditions. Selection of the risk-based approach is protective of the current industrial worker and recreational user and meets the following RAOs:

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

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

See Appendix F, Attachment F1, for maps that detail the location of the areas to be excavated (i.e., “hot spots”).

Based on the evaluation, this alternative meets all the RAOs for the removal action, is effective, and can be implemented. Alternative 4 is the most cost-effective option that meets the requirements of effectiveness, implementability, and RAOs.

6. REFERENCES

BJC 2006. *Cultural Resources Management Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, BJC/PAD-691/R1, March.

CDM 1994. *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Doc. No. 7916-003-FR-BBRY, Paducah, KY.

CH2M HILL 1991. *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant*, KY/ER-4, CH2M HILL Southeast, Inc., Oak Ridge, TN, March.

CH2M HILL 1992. *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant*, KY/SUB/13B-97777C P-03/191/1, CH2M HILL Southeast, Inc., Oak Ridge, TN, April.

Clausen, J. L., Douthitt, J. W., Davis, K. R., and Phillips, B. E. 1992. *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*, KY/E-150, Paducah, KY.

Clausen, J. L., 1996. *Preliminary Site Characterization/Baseline Risk Assessment for the Lasagna™ Technology Demonstration at Solid Waste Management Unit 91 of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-128.

COE (U.S. Army Corps of Engineers) 1992. *Final Report, Paducah Gaseous Diffusion Plant PCB Source Identification Project, Paducah, Kentucky*, U.S. Army Corps of Engineers, Nashville District, Nashville, TN, July.

COE (U.S. Corps of Engineers) 1994a. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky,* United States Army Corps of Engineers, Nashville, TN, May.

COE 1994b. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume V: Floodplain Investigation, Part A: Results of Field Survey,* United States Army Corps of Engineers, Nashville, TN, May.

COE 1994c. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume II: Threatened and Endangered Species Investigation*, United States Army Corps of Engineers, Nashville, TN, May.

COE 1996. *Paducah Gaseous Diffusion Plant PCB Sediment Survey, Big Bayou Creek and Little Bayou Creek, Paducah, Kentucky, Final Report*, United States Army Corps of Engineers, Nashville District, Nashville, TN, December.

DOE (U.S. Department of Energy) 1992. *Interim Corrective Measure Workplan for Institutional Control of Off-Site Contamination in Surface Water; Outfalls, Creeks, and Lagoons*, DOE-OR 1030, U.S. Department of Energy, Paducah, KY.

DOE 1994a. *Secretarial Policy on the National Environmental Policy Act*, U.S. Department of Energy, June.

DOE 1994b. *Remedial Investigation Addendum for WAG 22 Burial Grounds, Solid Waste Management Units 2 and 3 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1141&D1, U.S. Department of Energy, Paducah, KY, September.

DOE 1995. *Final Site Evaluation Report for the Outfall 010, 011, 012 Areas, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1434&D1, U.S. Department of Energy, Paducah, KY, December.

DOE 1996a. *Final Site Evaluation Report for WAG 15, C-200-A UST, and C-710-B UST, Paducah Gaseous Diffusion, Paducah, Kentucky,* DOE/OR/07-1540&D1, U.S. Department of Energy, Paducah, KY, December.

DOE 1996b. *1995 Summary of Actions to Eliminate/Minimize Polychlorinated Biphenyl (PCB) Effluent Releases at the Paducah Gaseous Diffusion Plant*, U.S. Department of Energy, Paducah, KY, January.

DOE 1997a. *Action Memorandum for Waste Area Group 23 and Solid Waste Management Unit 1 of Waste Area Group 27, PCB Sites, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1626&D1, U.S. Department of Energy, Paducah, KY, September.

DOE 1997b. *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1586&D2, U.S. Department of Energy, Paducah, KY, June.

DOE 1998. *Remedial Investigation Report of Solid Waste Management Units 7 and 30 of Waste Area Grouping 27 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1604&D2, U.S. Department of Energy, Paducah, KY, January.

DOE 1999. *Remedial Investigation Report for Waste Area Grouping 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1777/V2&D1, U.S. Department of Energy, Paducah, KY, June.

DOE 2001. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* Volume 1, *Human Health,* and Volume 2, *Ecological*, DOE/OR/07-1506&D2, U.S. Department of Energy, Paducah, KY, December.

DOE 2002a. *Record of Decision for Interim Remedial Action for Sections 1 and 2 at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1948&D2/R1, U.S. Department of Energy, Paducah, KY, September.

DOE 2002b. *Engineering Evaluation/Cost Analysis for Site-Wide Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1958&D1/R1, U.S. Department of Energy, Paducah, KY, February.

DOE 2005. *Sampling and Analysis Plan for Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2137&D2/R2, U.S. Department of Energy, Paducah, KY, May.

DOE 2006, *Surface Water Operable Unit (On-Site) Site Investigation and Baseline Risk Assessment Report at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0001&D1, U.S. Department of Energy, Paducah, KY, November.

DOE 2007a. *Site Management Plan Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-0009&D2, U.S. Department of Energy, Paducah, KY, October.

DOE 2007b. *Community Relations Plan Under the Federal Facility Agreement at the U.S. Department of Energy Paducah Gaseous Diffusion Plant*, DOE/OR/07-2099&D2/R5, U.S. Department of Energy, Paducah, KY, April.

EPA (U.S. Environmental Protection Agency) 1992. *Dermal Exposure Assessment: Principles and Application,* EPA/600/8-91/011B, Interim Report, January.

EPA 1993. *Guidance on Conducting Non-Time-Critical Removals under CERCLA, EPA, Office of Emergency and Remedial Response*, EPA/540R-93/057, OSWER Directive 9360.0-32, August.

EPA 1998a. *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, U.S. Environmental Protection Agency, Atlanta, GA, February 13.

EPA 1998b. *EPA's Contaminated Sediment Management Strategy*, U.S. Environmental Protection Agency, EPA-823-R-98-001, April.

EPA 1999. *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, U.S. Environmental Protection Agency, EPA-540-R-98-031, OSWER 9200.1- 23P, July.

EPA 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, U.S. Environmental Protection Agency, EPA-540-R-99-005, OSWER 9285.7- 02EP, July.

EPA 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, U.S. Environmental Protection Agency, EPA-540-R-05-012, OSWER 9355.0-85, December.

Huber, W. C., and R. E. Dickinson 1988. *Storm Water Management Model (SWMM)*, Version 4: User's Manual, EPA/600/3-88/001a.

KSNPC 1991. *Biological Inventory of the Jackson Purchase Region*, Kentucky State Nature Preserves Commission, Frankfort, KY 1991.

LMES (Lockheed Martin Energy Systems, Inc.) 1997. *1996 Summary of Actions to Eliminate/Minimize Polychlorinated Biphenyl (PCB) Effluent Releases at the Paducah Gaseous Diffusion Plant,* KY/EM-125 R1, Lockheed Martin Energy Systems, Inc., Paducah, KY, March.

Mills, W. B., J. D. Dean, D. B. Porcella, S. A. Gherini, R. J. M. Hudson, W. E. Frick, G. L. Rupp, and G. L. Bowie 1982. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants: Parts 1,2, and 3,* U.S. EPA Environmental Research Laboratory, Office of Research and Development, EPA-6001 6-82-004, Athens, GA.

PRS (Paducah Remediation Services, LLC) 2007. *Surface Water to Groundwater Interaction at the Paducah Gaseous Diffusion Plant,* PRS-ENR-0026, Paducah Remediation Services, LLC, Paducah, KY, November.

TCT-St. Louis 1991. *Phase I Remedial Investigation at the Former Kentucky Ordnance Works, McCracken County, Kentucky*, 1321K.920818.006, U.S. Army Corps of Engineers, Nashville District, Nashville, TN, November.

USDA (U.S. Department of Agriculture) 1976. *Soil Survey of Ballard and McCracken Counties, Kentucky*, USDA Soil Conservation Service and Kentucky Agricultural Experiment Station.

APPENDIX A

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE/TO BE CONSIDERED REQUIREMENTS

THIS PAGE INTENTIONALLY LEFT BLANK

Table A.1. Summary of Chemical-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Radiation Protection of the Public and the Environment	DOE Order 5400.5(II)(1)(a) and (2)	Except under unusual circumstances, the exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an EDE greater than 100 mrem. The ALARA process shall be implemented for all DOE activities and facilities that cause public doses.	The substantive requirements are TBC, and activities necessary to comply will be incorporated into the planning phase of the preferred alternative.

Table A.1. Summary of Chemical-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Toxic Substances Control Act	40 *CFR* § 761.61 (c)	TSCA provides for risk-based cleanup of PCBs when the method will not pose an unreasonable risk of injury to health or the environment.	The substantive requirements are applicable for excavation to the proposed PCB risk-based levels. Activities necessary to comply will be incorporated into the planning phase of the preferred alternative.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
EDE = effective dose equivalent
KAR = *Kentucky Administrative Regulations*
mrem = millirem
PCB = polychlorinated biphenyl
TBC = to be considered
TSCA - Toxic Substance Control Act

Table A.2. Summary of Location-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Protection of Wetlands	10 *CFR* Part 1022; 40 *CFR* § 230.10 (c)	Activities must avoid or minimize impacts to wetlands to preserve and enhance their natural and beneficial value. If wetland resources are not avoided, measures must be taken to address ecologically sensitive areas and mitigate adverse effects. Such measures may include minimum grading requirements, runoff controls, design and construction considerations. Allows minor discharges of dredge and fill material or other minor activities for which there is no practicable alternative, provided that the substantive requirements of NWPs (TBCs 14, 18, 33, and/or 38) are met.	The substantive requirements are applicable if impacts to wetlands cannot be avoided during implementation of the preferred alternative. As referenced in Section 4.1.1, NWPs otherwise would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.
Protection of Aquatic Ecosystems	40 *CFR* § 230.10 (a) & (d)	Prohibits discharge of dredge or fill materials into waters of the United States if there is a practical alternative that would have less adverse impact on aquatic ecosystems. Allows minor discharges of dredge and fill material or other minor activities for which there is no practicable alternative, provided that the substantive requirements of NWPs (TBCs 14, 18, 33, and/or 38) are met.	The substantive requirements are applicable because of the close proximity of Little Bayou and Bayou Creeks to areas where the preferred alternative will be implemented. As referenced in Section 4.1.1, NWPs otherwise would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.

Table A.2. Summary of Location-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Nationwide Permit Program	33 *CFR* § 330.5	NWPs are a type of general permit issued by the Corps of Engineers and are designed to regulate, with little if any delay or paperwork, certain activities having minimal impacts. NWPs can be issued to satisfy the permit requirements of Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, Section 103 of the Marine Protection, Research, and Sanctuaries Act, or some combination thereof.	Unless impacts to wetlands or aquatic ecosystems are avoided or an alternative is selected that does not impact wetlands or aquatic ecosystems, compliance with the substantive TBC requirements of NWPs 14, 18, 33, and/or 38 would be required as follows: 1. Backfilling an excavation and excavation of hazardous sediments in a water body or wetland would require a combination of NWP 38 – Cleanup of Hazardous and Toxic Waste and NWP 18 – Minor Discharges. 2. Construction of a temporary access road across a water body or wetland would require NWP 33 – Temporary Construction Access. 3. Construction of a permanent access road across a water body or wetland would require

Table A.2. Summary of Location-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			NWP 14 – Linear Transportation Projects. These substantive TBC requirements will be delineated in the RAWP after final alternative selection. As referenced in Section 4.1.1, NWPs otherwise would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.
Endangered Species Act	16 *USC* 1531 *et seq.* § 7(a)(2); 50 *CFR* Part 402	Actions that jeopardize the existence of listed species or result in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures must be taken.	The substantive requirements are applicable because critical habitat for T&E species is present near PGDP, outside the industrialized area. The requirements will be met through avoidance of critical habitat or mitigation measures.
Migratory Bird Treaty Act	16 *USC* 703-711; 50 *CFR* Part 21	Prohibits killing, unlawful taking, possession, and sale of almost all species of native birds in the U.S.	The substantive requirements are applicable because migratory birds frequent PGDP. As referenced in Section

Table A.2. Summary of Location-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			4.1.1, permits otherwise may be required if migratory birds are taken (i.e., taking cannot be avoided) in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.
Memorandum of Agreement - Migratory Bird Treaty Act	Executive Order 13186	Under a Memorandum of Understanding signed between DOE and the U.S. Fish and Wildlife Service (USFWS) DOE shall: • Avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions; • Restore and enhance the habitats of migratory birds, as practicable; • Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable; • Identify where unintentional uptake likely will result from agency actions and develop standards and/or practices to minimize such unintentional take; and • Obtain permits if required for the taking of migratory birds.	Should the selected alternative impact migratory birds, substantive TBC requirements such as scheduling construction time around nesting seasons or controlling airborne pollution will be delineated in the RAWP.
Protection of Water Resources and Floodplain Management	10 *CFR* Part 1022; 401 *KAR* 4:060, Section 4	Protects floodplains and streams by regulating fill, deposits, obstructions, excavation, or storage of materials or structures that may adversely affect the floodway, stream channel, or drainage capability of a stream or flowing body of water.	The substantive requirements are applicable because of the close proximity of Little Bayou and Bayou Creeks to areas where the preferred alternative will

Table A.2. Summary of Location-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			be implemented. If encroachments cannot be avoided, the substantive requirements for uses of regulatory floodway will be met by ensuring that the encroachments shall have "no impact" or not result in any increase in flood levels during occurrence of the base flood discharge. Dredging or other removal of material from between the stream banks and the regulatory floodway may be conducted if disposal of the dredged material is outside of the floodway and does not result in increases in flood elevations.

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
USFWS = U.S. Fish and Wildlife Service
KAR = *Kentucky Administrative Regulation*
MOU = Memorandum of Understanding
NEPA = National Environmental Policy Act
NWP = Nationwide Permit
PGDP = Paducah Gaseous Diffusion Plant
RAWP = Removal Action Work Plan
T&E = threatened and endangered species
TBC = to be considered
USC = *United States Code*

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Kentucky Water Quality Criteria • Designated Uses of Surface Water • Surface Water Standards • KPDES Program	401 *KAR* 5:026; 401 *KAR* 5:031, Sections 1 – 7, excluding Section 2(1)(g) and Section 3(3)(d); KPDES Permit KY0004049; 401 KAR 5:055, Section 1; 401 KAR 5:070, Section 4	KPDES Program provides designated uses of surface waters and physical and chemical-specific numeric standards for pollutants discharged or found in surface waters and in domestic water supplies. The KPDES program requires a permit to discharge pollutants from a point source into waters of the Commonwealth. Compliance with the KPDES program requirements constitutes compliance with the operational permit requirements of 401 *KAR* 5:005 and requirements related to the operational permit.	The substantive standards of the regulations are applicable and implemented through the TBC effluent limits in the KPDES permit. BMPs will be implemented to control storm water and sedimentation runoff. As referenced in Section 4.1.1, a KPDES permit would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Fugitive Dust Emissions during Site Preparation and Construction Activities	401 *KAR* 63:010	Precautions must be taken to prevent particulate matter from becoming airborne. Such precautions must be incorporated into the planning and design of activities and include actions such as these: • Wetting or adding chemicals to control dust from construction activities; • Using materials such as asphalt or concrete (or other suitable chemicals/fixing agents) on roads or material stockpiles to prevent fugitive emissions; and • Using covers on trucks when transporting materials to and from the construction site(s). This requirement specifies that, for on-site construction activities, no visible emissions may occur at the PGDP fence line.	The substantive requirements are applicable and will be met through the use of appropriate dust control practices identified during the design phase for the preferred alternative.
Toxic Emissions and National Emission Standards for Hazardous Air Pollutants	401 *KAR* 63:020, Section 3; 40 *CFR* § 61.92	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. The radiological dose to the most exposed member of the public resulting from sitewide radionuclide emissions to the atmosphere must not exceed 10 mrem/year.	The substantive requirements are applicable. Based on preliminary evaluation of similar removal actions at the PGDP, it is anticipated that emissions will not exceed the *KAR* or NESHAPS limits. Verification modeling will be conducted and the results presented in the RAWP.

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Toxic Substances Control Act	40 *CFR* § 761.61 (c)	TSCA provides for risk-based cleanup of PCBs when the method will not pose an unreasonable risk of injury to health or the environment.	The substantive requirements are applicable if the selected alternative includes excavation to the proposed PCB risk-based levels. Activities necessary to comply will be incorporated into the planning phase of the preferred alternative.
Public Dose Limits	DOE Order 5400.5 II(1)(b)	The public dose limits apply to doses from exposures to radiation sources and radioactive materials released to the atmosphere from routine DOE activities, including remedial actions.	The substantive requirements are TBC during implementation of the preferred alternative. Exposure limits from materials released to the atmosphere will not be exceeded through the use of appropriate dust control practices identified during the planning phase for the preferred alternative.
Management and Control of Radioactive Materials in Liquid Discharges	DOE Order 5400.5, Chapter II(3)(a)	At the point of discharge from the conduit to the environment, control must be imposed on liquid releases to protect resources such as land, surface water, groundwater, and the related ecosystems from undue contamination.	The substantive requirements are TBC because of the potential for discharges of radioactive material in liquid

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			discharges. Activities necessary to comply will be incorporated into the planning phase of the preferred alternative.
Low-Level Waste Management	DOE Order 435.1 and DOE M. 435.1-1	Provides DOE requirements for characterization, packaging, certification, and disposal of LLW, mixed LLW, and TSCA-contaminated LLW waste.	The substantive requirements are TBC and compliance will be ensured through the characterization and appropriate management of LLW wastes generated as a result of implementing the preferred alternative. Waste management will be predicated upon waste characterization and comply with the substantive TBC requirements associated with LLW management.
Hazardous Waste Management	401 *KAR* Chapters 30–34 and 37	All wastes or environmental media containing wastes must be characterized to determine whether the waste also is a hazardous waste. If it is determined that a waste is a hazardous waste or that environmental media contain a hazardous waste subject to the *KAR* regulations, requirements of the *KAR* are applicable.	The substantive requirements are applicable on-site and compliance will be ensured through the characterization and appropriate management

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			of hazardous wastes and environmental media generated as a result of implementing the alternative. Waste management will be predicated upon waste characterization and will comply with all substantive requirements associated with on-site hazardous waste management, as appropriate. Hazardous waste sent off-site will be managed in accordance with the substantive and administrative requirements of applicable regulations. For contained-in/no-longer-contaminated-with determinations, the waste will be characterized to apply the TCE/TCA contained-in/no-longer-contaminated levels of 39.2 ppm TCE in solids and .081 ppm TCE in water to media and debris generated by this action.

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			The characterization plan will be subject to regulator review and approval under the procedures outlined in the FFA. The characterization results will be compared against the contained-in, health-based levels listed above, and a contained-in determination will be made. Land Disposal Restrictions apply to media and debris that no longer contain or are no longer contaminated with RCRA regulated waste. As referenced in Section 4.1.1, a Treatment, Storage, and Disposal permit would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.
PCB Waste Management	40 *CFR* Part 761; 40 *CFR* § 761.65(b);	General TSCA requirements for the management of PCB wastes or items include the following: • Management of waste and material; • Characterization of PCB-containing materials;	The substantive requirements are applicable if PCBs are identified as regulated under 40 *CFR* Part 761. Activities necessary to

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
	40 *CFR* § 761.61 (c)	• Labeling and storage for disposal; • Manifest completion for shipment off-site; • Decontamination of affected equipment or items; and • Disposal of PCB wastes. Or In addition, TSCA provides for risk-based storage of PCBs when the method will not pose an unreasonable risk of injury to health or the environment.	comply with these ARARs shall be incorporated into the RAWP for the selected alternative. For up to 180-days, PCB remediation wastes will be managed/stored in risk-based storage instead of storage meeting 40 *CFR* § 761.61(b) requirements. Such wastes will be stored up to 180-days in drums, B-12 boxes, B-25 boxes, Intermodal containers, and/or Sealand containers, provided that the containers are sealed when not adding/removing materials. Storing PCB Remediation wastes in this manner (which will be further detailed in the RAWP) provides a level of protectiveness that is similar to storing PCB remediation wastes in piles under 40 *CFR* § 761.65(c)(9).
Disposal of PCB Remediation Waste	40 *CFR* § 761.61(a), (b), and (c)	Provides requirements and options for disposing of PCB remediation waste. Options include methods for performance based, risk-based, and coordinated approval disposal.	The substantive requirements are relevant and appropriate. DOE will perform on-site risk-based

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			cleanup; however, wastes containing equal to or less than 49 ppm PCBs will be disposed of on-site at the C-746-U solid waste landfill pursuant to substantive requirements of 40 *CFR* § 761.61(a)(5)(v). The Environmental Performance Standard in 401 *KAR* 47:030, Section 8 and referenced in Condition Number T-66 of Solid Waste Permit No. 073-00014/073-00015/073-00045 currently allow such disposal. PCB remediation waste above 49 ppm will be disposed off-site at Energy*Solutions* in Clive, Utah, or the Nevada Test Site under a current coordinated approval in accordance with 40 *CFR* § 761.61(b). An alternate facility (facilities) for disposal of PCB remediation waste may be used if the receiving

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
			facility is a performance based facility under 40 *CFR* § 761.61(b) or an approved risk-based disposal facility as allowed in 40 *CFR* § 761.61(c). PCB waste disposed off-site will be managed in accordance with the substantive and administrative requirements of applicable regulations. As referenced in Section 4.1.1, a Solid Waste Landfill permit would be required in the absence of CERCLA Section 121(e)(1) and the National Contingency Plan.
Disposal of Waste with Residual Radioactive Material Off-Site	DOE Order 5400.5(II)(5)(c)(6) and 5400.5(IV)(5)(a)	If residual radioactive material is released to a non-DOE or non-NRC licensed facility, the waste must achieve authorized limits equal to the specific guidelines derived from the basic dose limit using DOE/CH-8901a (or equivalent) in accordance with DOE Order 5400.5 (IV)(4)(a) before that release. Authorized limits shall be consistent with limits and guidelines established by other applicable federal and state laws.	The substantive requirements are TBC prior to the release of residual radioactive material to a non-DOE or non-NRC licensed facility for disposal.
Disposal of Waste with Residual Radioactive Material in the C-746-U	DOE Order 5400.5(IV)(5)(a)	Disposal of residual radioactive material must achieve the authorized limits equal to the specific guidelines derived from the basic dose limit using DOE/CH-8901a (or equivalent) in accordance with DOE	The substantive requirements are TBC for waste with residual

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
Landfill		Order 5400.5 (IV)(4)(a).	radioactive materials disposed on-site in the C-746-U Landfill. The substantive requirements will be met through compliance with the already established authorized limits for the C-746-U Landfill.
Transportation of Hazardous Materials, including RCRA, PCB, and Radioactive Waste	49 *CFR* Part 171; 40 *CFR* § 761.207; 401 *KAR* Chapters 32 and 34	Provides requirements for marking, labeling, placarding, packaging, manifesting, emergency response, obtaining an identification number, use of transporters, recordkeeping, etc., when transporting or offering for transport hazardous materials, including hazardous, radioactive , and PCB waste in commerce.	The substantive requirements are applicable during the on-site manifesting, labeling, packaging, and transportation of hazardous, PCB and radioactive waste that may be generated during implementation of the preferred alternative. Off-site transportation will be conducted in accordance with the administrative and substantive requirements of the applicable regulations.
Transportation of LLW	DOE Order 435.1 and DOE M	Provides requirements for packaging and transporting LLW.	The substantive requirements are TBC

Table A.3. Summary of Action-Specific ARARs/TBCs for the Contaminated Sediment Associated with the Surface Water Operable Unit (Continued)

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
	435.1-1		during the labeling, packaging, and transportation of low-level waste that may be generated during implementation of the preferred alternative.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
AWQC = Ambient Water Quality Criteria
BMP = best management practice
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = *Code of Federal Regulations*
CWA = Clean Water Act
DOE = U.S. Department of Energy
FFA = Federal Facility Agreement
KAR = *Kentucky Administrative Regulation*
KPDES = Kentucky Pollutant Discharge Elimination System
LLW = low level waste
NESHAPS = National Emission Standards for Hazardous Air Pollutants
NRC = Nuclear Regulatory Commission
PCB = polychlorinated biphenyl
PGDP = Paducah Gaseous Diffusion Plant
RAWP = Removal Action Work Plan
RCRA = Resource Conservation and Recovery Act
TBC = to be considered
TCA = trichloroethane
TCE = trichloroethene
TSCA = Toxic Substances Control Act

APPENDIX B

COST ESTIMATE AND CONCEPTUAL DESIGN

THIS PAGE INTENTIONALLY LEFT BLANK

Table B.1. Alternative 2 – Institutional Controls Cost Analysis

Alternative 2 Cost Analysis

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
1	**Project Management**		80	Hrs	77.20	6,176.0
2	**Project Planning**					
	2.1 Procedures 2.2 Plans 2.3 Design	Site security and control Site-specific HASP and SAP Fencing and signage specifications	200 100 120	Hrs Hrs Hrs	64.40 64.40 60.66	12,880.0 6,440.0 7,279.2
3	**Execution**					
	3.1 HP Support 3.2 Superintendent 3.3 HSO	Construction subcontractor support Construction subcontractor support Construction subcontractor support	50 100 100	Hrs Hrs Hrs	46.37 54.57 60.66	2,318.5 5,457.0 6,066.0
4	**Administration**					
	4.1 Procurement 4.2 Contracting 4.3 Other Administrative Adders	Supplies, bid packages Subcontract Assumes 5% of capital	32 40 1	Hrs Hrs L.S.	27.57 27.57 22,456.50	882.2 1,102.8 22,456.5
5	**Site Prep**					
	5.1 Survey **5.2 Clear and Grub** **5.3 Utility Locate**	2-man crew Cut and chip trees, clear brush; area needed for fence installation only	5 2 16	Day Acres Hrs	720.0 6,000 37.40	3,600.0 12,000.0 598.4
6	**Security Fencing**	Installed cost, 8', 6 gauge, galvanized chain link, 3 strand barbed wire, 2" posts at 10' O.C. – Hot spot and buffer areas	11,600	L.F.	32.07	372,012.0
7	**Gate**	20'x8', 6 gauge, galvanized chain link, 3 strand barbed wire	10	Ea.	1,181.80	11,818.0

Table B.1. Alternative 2 – Interim Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
8	**Signage**	Hazard postings	1	L.S.	500.00	500.0
9	**Other Adders**	Tax, overhead, fringe, etc. @ 20% of capital	1	L.S.	94,317.30	94,317.3
		Subtotal Capital				***565,903.9***
10	**O&M**			.		
	10.1 Sampling Labor		2,400	Hrs	37.21	89,304.0
	10.2 KPDES water sampling	Annual sampling for KPDES parameters (pest, PCBs, radiological, metals, VOCs, SVOCs) in NSDD and stormwater collection systems	120	Ea.	3,751.00	450,120.0
	10.3 Sample shipping	6 coolers/yr.	6	Ea.	750.00	4,500.0
	10.4 Env. Compliance	Data interpretation and annual reporting	80	Hrs.	64.40	5,152.0
	10.5 Maintenance and Inspections	Fencing and postings	1	L.S.	9,600.00	9,600.0
		Subtotal O&M				***558,676.0***
		Grand Total				***1,124,579.9***
		Cost/Benefit Analysis				
		Capital Cost (2006$) Annual Cost (O&M) (2006$) Design Life (yrs) Present Value Total Cost with 30-year O&M (2006$) Escalated Total Cost with 30-year O&M (2006$)				565,903.9 558,676.0 30.0 17,326,183.9 27,150,171

Table B.2. Alternative 3 – Combination of Engineering Controls and Institutional Controls Cost Analysis

Alternative 3 Cost Analysis

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
1	**Project Management**		240	Hrs	77.20	18,528.0
2	**Project Planning**					
	2.1 Procedures 2.2 Plans 2.3 Design	Site security and control Site-specific HASP and SAP Design, specifications, bid package	200 100 120	Hrs Hrs Hrs	64.40 64.40 60.66	12,880.0 6,440.0 7,279.2
3	**Execution**					
	3.1 HP Support 3.2 Superintendent 3.3 HSO	Construction subcontractor support Construction subcontractor support Construction subcontractor support	100 200 125	Hrs Hrs Hrs	46.37 54.57 60.66	4,637.0 10,914.0 7,582.5
4	**Administration**					
	4.1 Procurement 4.2 Contracting 4.3 Other Administrative Adders	Supplies, bid packages Subcontract Assumes 5% of capital	40 60 1	Hrs Hrs L.S.	27.57 27.57 112,110.6	1,102.8 1,654.2 112,110.6
5	**Mob/Demob**					
	5.1	Portable toilet, assume 1-month rental	1	Month	300.00	300.0
6	**Site Prep**					
	6.1 Survey **6.2 Clear and Grub** **6.3 Utility Locate**	2-man crew Cut and chip trees, clear brush; hot spot areas and equipment staging areas 	5 4 16	Day Acres Hrs	720.00 6,000.00 37.40	3,600.00 24,000.0 598.4

Table B.2. Alternative 3 – Combination of Engineering Controls and Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
7	**Ditch Barrier/Lining**	Quantities include excess material for anchor trench and constructability				
	7.1 Geo-net	200-mill, 45 lb/in., installed	158,000	Ft^2	1.05	165,900.0
	7.2 Geotextile	20-mill woven for rock-check dam construction	158,000	Ft^2	0.86	135,880.0
	7.3 HDPE Liner	80-mill textured, installed	158,000	Ft^2	1.71	270,180.0
	7.4 Sheet Piling	Light-intermediate ¼" steel sheet piling driven to 5' below grade, installed	6,540	Ft^2	167.00	1,092,180.0
	7.5Angle Iron	3x3x1/4' for liner clip	1,307	L.F.	2.89	3,777.2
	7.6 Flat Iron	3x1/4' for liner clip	1,307	L.F.	2.43	3,176.0
	7.7 Fasteners	Misc. for liner clip	1	L.S.	11,000.00	11,000.0
	7.8 Labor	Foreman	250	Hrs	40.00	10,000.0
	7.9 Labor	Operator	250	Hrs	36.00	9,000.0
	7.10 Labor	Laborer	250	Hrs	27.50	6,875.0
	7.11 Labor	Welder	130	Hrs	36.00	4,680.0
	7.12 Vibratory compactor	Not specified	130	Hrs	45.00	5,850.0
	7.13 Trackhoe	JD 160C or equivalent	170	Hrs	185.10	31,467.0
	7.14 Bobcat	Case 521C or equivalent	150	Hrs	56.00	8,400.0
8	**Security Fencing**	Installed cost, 8', 6 gauge, galvanized chain link, 3 strand wire, 2" posts at 10' O.C.; Hot spot and buffer area	11,600	L.F.	32.07	372,012.0
9	**Gate**	20'x8', 6 gauge, galvanized chain link, 3 strand barbed wire	10	Ea.	1,181.80	11,818.0
10	**Signage**	Hazard postings	1	L.S.	500.00	500.0
11	**Other Adders**	Tax, overhead, fringe, etc. @ 20% of capital	1	L.S.	470,864.4	470,864.4
		Subtotal Capital				***2,851,186.3***

Table B.2. Alternative 3 – Combination of Engineering Controls and Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
12	**O&M**					
	12.1 Sampling labor		2,400	Hrs	37.21	89,304.0
	12.2 KPDES water Sampling	Annual sampling for KPDES parameters (pest., PCBs, radiological, metals, VOCs, SVOCs) in NSDD and stormwater collection systems	120	Ea.	3,751.00	450,120.0
	12.3 Sample Shipping	6 coolers/yr.	6	Ea.	750.00	4,500.0
	12.4 Env. Compliance	Data interpretation and annual reporting	80	Hrs.	64.40	5,152.0
	12.5 Maintenance and Inspections	Fencing and postings; O&M of engineering controls	1	L.S.	11,000.0	13,500.0
		Subtotal O&M				***562,576.0***
		Grand Total				***3,387,762.3***
		Cost/Benefit Analysis				
		Capital Cost (2006$) Annual Cost (O&M) (2006$) Design Life (yrs) Present Value Total Cost with 30-year O&M (2006$) Escalated Total Cost with 30-year O&M (2006$)				2,825,186.3 562,576.0 30.0 19,702,466.3 29,760,323.0

Table B.3. Alternative 4 – Excavation and Institutional Controls Cost Analysis

Alternative 4 Cost Analysis

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
1	**Project Management**		500	Hrs	77.20	38,600.0
2	**Project Planning**					
	2.1 Procedures 2.2 Plans 2.3 Design	Site security and control Site-specific HASP and SAP Design, specifications, bid package	200 400 400	Hrs Hrs Hrs	64.40 64.40 60.66	12,880.0 25,760.0 24,264.0
3	**Execution**					
	3.1 HP Support 3.2 Superintendent 3.3 HSO	Construction subcontractor support Construction subcontractor support Construction subcontractor support	1,230 550 410	Hrs Hrs Hrs	46.37 54.57 60.66	57,035.1 30,013.5 24,870.6
4	**Administration**					
	4.1 Procurement 4.2 Contracting 4.3 Other Administrative Adders	Supplies, bid packages Subcontract Assumes 5% of capital	120 160 1	Hrs Hrs L.S.	27.57 27.57 302,810.2	3,308.4 4,411.2 302,810.2
5	**Mob/Demob**					
	5.1 5.2	Portable toilet, assume 1-month rental Office trailer	2 2	Month Month	300.00 500.00	600.0 1,000.0
6	**Decontamination**					
	6.1 Decon pad 6.2 Decon water treatment 6.3 storage drums 6.4 PPE 6.5 Decon equipment	 3 persons, 60 days Pressure washer	1 10,000 100 180 1	L.S. Gallons Drums Ea. Ea.	600.00 1.30 50.60 33.80 400.00	600.0 13,000.0 5,060.0 6,084.0 400.0
7	**Site Prep**					

Table B.3. Alternative 4 – Excavation and Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
	7.1 Survey 7.2 Clear and Grub 7.3 Utility locate	2-man crew Hot spots and area for equipment staging	10 4 24	Day Acre Hrs	720.00 6,000.00 37.40	7,200.0 24,000.0 897.6
8	**Excavation**					
	8.1 Load and haul 8.2 Dewatering	158,123 ft^2 - assumes excavation to 2 ft; includes driver and truck rental	11,713 14	Yd^3 Day	65.00 500.00	761,345.0 7,000.0
9	**Rebuild ditch**					
	9.1 Select Fill 9.2 Compact	Assume 5,000 L.F.	1,000 75	Yd^3 Hrs	15.00 7.15	15,000.0 536.3
10	**Waste Disposal**	Disposal volume includes swell and excess material				
	10.1 Off-Site 10.2 Transportation 10.3 Off-Site Disposal 10.4 On-Site Disposal	65% NSDD; 49% Internal ditches Gondola @ 2,000 ft^3 Energy*Solutions* U-Landfill; cost included in load and haul	6,271 85 162,454 6,915	Yd^3 Railcar Ft^3 Yd^3	 15,631.00 14.71 NA	 1,328,635.0 2,389,698.3 NA
11	**Waste Treatment**	Assumes the potential that 10% of areas containing chromium and lead will fail TCLP				
		NSDD – Macro (includes treatment and shipment) Outfalls – Stabilization (includes treatment and shipment)	2,074 4,789	Ft^3 Ft^3	128.86 73.07	267,255.6 349,932.2
12	**Removal Action Labor**					
	12.1 Labor 12.2 Labor 12.3 Labor	Foreman Operator Laborer	450 450 450	Hrs Hrs Hrs	40.00 36.00 27.50	18,000.0 16,200.0 12,375.0

Table B.3. Alternative 4 – Excavation and Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
13	**Embankment Stabilization and Site Restoration**					
	13.1 Revegetation	Fertilize, mulch, seed; hot spot area and staging area	4	Acre	1,500.00	6,000.0
	13.2 Contour	Cat D-6 or equivalent, 3.6 acres (hot spot area)	16	Hrs	65.00	1,040.0
	13.3 Silt fence	Installed cost, adverse conditions; hot spot and buffer areas	11,600	L.F.	0.32	3,712.0
	13.4 Erosion Control Matting	Stapled polypropylene mesh for embankment stabilization	14,100 3,000	Yd^2 Yd^3	1.84 75.00	25,944.0 225,000.0
	13.5 Rip-rap small	5 to 20 lb angular rock for embankment stabilization	140	Hrs	40.00	5,600.0
	13.6 Labor	Foreman	140	Hrs	36.00	5,040.0
	13.7 Labor	Operator	140	Hrs	27.50	3,850.0
	13.8 Labor	Laborer	55	Hrs	185.10	10,180.5
	13.9 Trackhoe; Excavator	JD160C or equivalent	55	Hrs	56.00	3,080.0
	13.10 Front End Loader	Case721C or equivalent				
14	**Security Fencing**	Installed, Barricade Safety Fence, orange, woven, polypropylene, UV stabilized, pre-posts, 10' O.C.; Hot spot and buffer areas	11,600	L.F.	1.43	16,588.0
15	**Signage**	Hazard postings	1	L.S.	500.00	500.0
16	**Verification Sampling**	Verification				
	16.1 Sampling labor		80	Hrs	37.21	2,976.8
	16.2 Samples	Verification sampling for KPDES parameters (pest., PCBs, radiological, metals, VOCs, SVOCs)	78	Ea.	3,751.00	292,578.0
	16.3Sample shipping	4 Coolers	4	Ea	750.00	3,000.0
	16.4Env. Compliance	Data interpretation and reporting	80	Hrs	64.40	5,152.0

Table B.3. Alternative 4 – Excavation and Institutional Controls Cost Analysis (Continued)

Cost Item	*Description*	*Extended Description*	*Quantity*	*Unit*	*Unit Cost ($)*	*Extended Cost ($)*
17	**Other Adders**	Tax, overhead, fringe, etc., @ 20% of capital	1	L.S.	1,271,802.7	1,271,802.7
		Subtotal Capital				***7,630,816.0***
18	**O&M**					
	18.1 Maintenance and Inspections	Fencing, postings, repair restoration	1	L.S.	5,000.00	5,000.0
		Subtotal O&M				***5,000.0***
		Grand Total				***7,635,816.0***
		Cost/Benefit Analysis				
		Capital Cost (2006$) Annual Cost (O&M) (2006$) Design Life (yrs) Present Value Total Cost with 30-year O&M (2006$) Escalated Total Cost with 30-year O&M (2006$)				7,630,816.0 5,000.0 30.0 7,780,816.0 8,310,533.0

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C

EVALUATION OF SEDIMENTATION BASINS AT OUTFALLS 008 AND 011

THIS PAGE INTENTIONALLY LEFT BLANK

This appendix summarizes the evaluation performed to determine if the need still exists for the construction and installation of new sedimentation basins at Paducah Gaseous Diffusion Plant Outfall 008 and Outfall 011. The need for the construction and installation of sedimentation basins previously was identified in the *Engineering Evaluation/Cost Analysis for the Site-Wide Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (EE/CA), DOE/OR/07-1958&D1/R1, prepared in 2002 (DOE 2002b).

The Site-Wide Sediment Controls EE/CA (DOE 2002b) identified the following uncertainties associated with Outfall 008 and Outfall 011:

Outfall 008

1) Future construction or remediation activities could create the opportunity for sediment and contaminated soil to be mobilized and transported to Bayou Creek;

2) Uncertainties as to the level of dissolved phase metals and radionuclides being discharged during storm flow events; and

3) Contribution and nature of process water is uncertain during normal operations and storm events.

Outfall 011

1) Future construction or remediation activities could create the opportunity for sediment and contaminated soil to be mobilized and transported to Little Bayou Creek;

2) Under existing conditions, some polychlorinated biphenyl- (PCB-) contaminated solid waste management units (SWMUs) and Building C-340 may present the opportunity for contaminated sediment/soil to be mobilized and transported. Plant ditches within Outfall 011 have an unknown level of contamination;

3) Uncertainties as to the level of dissolved phase metals and radionuclides being discharged during storm flow events; and

4) Contribution and nature of process water is uncertain during normal operations and storm events.

Based upon these uncertainties, the Site-Wide Sediment Controls EE/CA (DOE 2002b) recommended that control/remediation for Outfalls 008 and 011 be implemented using “Alternative 4” – “Localized Controls, Integrated Controls, and System Controls.” This included the excavation of a new section of outfall ditch and the installation of sediment control basins at Outfall 008 and Outfall 011.

Since the preparation of the Site-Wide Sediment Controls EE/CA (DOE 2002b), a comprehensive sitewide investigation of the Surface Water Operable Unit (SWOU) has been conducted. This investigation included Outfall 008 and Outfall 011. Results of the site investigation can be found in the *Surface Water Operable-Unit (On-Site) Site Investigation and Baseline Risk Assessment Report at the Paducah Gaseous Diffusion Plant Paducah Kentucky,* DOE/LX/07-0001&D1 (DOE 2006).

The SWOU (On-Site) SI/BRA included a detailed risk assessment for each of the outfalls and their associated internal ditches. The results of the risk assessment are summarized in Section 1.7 of this EE/CA. In addition to the risk assessment, the SWOU (On-Site) SI/BRA included surface water models (MUSLE and SWMM) for antimony, iron, uranium, Total PCBs, uranium-238 and Total PAHs. These models were performed to determine the predicted surface water concentration for a 30 year, 24 hour storm event at the outfalls and Little Bayou and Bayou Creeks. The model results show no exceedance for either Outfall 008 or Outfall 011 [see Appendix C of the SWOU (On-Site) SI/BRA and Section 1.6 of this report].

Based upon the data from the SWOU (On-Site) SI/BRA, the results of the risk assessment and the results of the surface water modeling, it has been determined that the need for the construction and installation of sediment basins for Outfall 008 and Outfall 011 is no longer warranted at this time.

The design of the excavation will consider routine sedimentation controls, such as small stormwater retention areas, silt fencing, rock check dams, mulching, and revegetation, as best management practices to prevent potential erosion and migration during excavation activities associated with this EE/CA. These are described in Section 3 and Section 4 of the EE/CA.

APPENDIX D

ANALYTICAL DATA AND QA/QC EVALUATION RESULTS (CD)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E

RISK EVALUATION

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix E presents the development of removal goal options (RGOs) and the screening of the 13 exposure units (EUs) identified in Section 1.7.1, "Human Health Risk," against those RGOs. The appendix provides the basis for the exposure parameters associated with the industrial worker, excavation worker, and recreational user and the human health uncertainties associated with the selection of contaminants of concern (COCs) under the various risk scenarios. The COCs indentified for the current industrial worker in this appendix also are utilized in Appendix F.

E.1.1 Removal Goal Options

Human health RGOs were derived for all contaminants of concern (COCs) using the methods for risk-based concentration calculation described in Appendix D of the Surface Water Operable Unit (SWOU) (On-Site) Site Investigation/Baseline Risk Assessment (SI/BRA) report (DOE 2006). Consistent with guidance in the Methods Document (DOE 2001) describing remedial goal option derivation, the targets used were 1×10^{-4}, 1×10^{-5}, and 1×10^{-6} for risk; 3.0, 1.0, and 0.1 for hazard; and 1, 15, and 25 mrem/year for radionuclide dose.

RGOs to protect receiving media (e.g., surface water/sediment) are not derived in this appendix because the removal action objectives (RAOs) do not include a response to address contaminant migration. Please see the main text and Appendix C for additional information regarding contaminant migration.

RGOs protective of human health were derived for the most likely future uses of Sections 3, 4, and 5 of the North-South Diversion Ditch (NSDD) and the internal ditches. For Sections 3, 4, and 5 of the NSDD, recreational and industrial were the most likely future uses considered (DOE 2006). For the internal ditches, industrial was considered the most likely future use (DOE 2006).

E.1.2 Exposure Parameters for the Industrial Worker, Excavation Worker, and Recreational User

Site-specific exposure parameters are used when deriving the RGOs. These site-specific exposure parameters and their basis are discussed in the following subsections.

E.1.2.1 Industrial Worker

The exposure frequency for the industrial worker under current site conditions was set to 14 days per year and a duration of 25 years.[10] This is consistent with the limitations on exposure under the current administrative controls, which will be continued through implementation of interim institutional controls of the selected alternative. The exposure frequency was based on process knowledge associated with actual work performed at Paducah Gaseous Diffusion Plant (PGDP). An ingestion rate was calculated based on the assumption that a worker's time was to be consumed by intrusive actives such as mowing and collecting samples from the hot spot. For this activity, a soil ingestion rate of 480 mg/day was assigned similar to that listed in the SWOU (On-Site) SI/BRA report for excavation workers (DOE 2006). Dermal exposure for the industrial worker was assumed to be limited by administrative procedures to the hand and facial areas only; therefore, the dermal exposure surface area was set at 0.193 m^2/day based on exposure surface areas listed in Table 8-3 of *Dermal Exposure Assessment: Principles and Application* (EPA 1992). The 0.193 m2/day is an average exposure to the hand and facial areas for both men and women.

[10] This is the type of worker that would maintain or inspect ditches.

E.1.2.2 Excavation Worker

The exposure parameters for the excavation worker under current site conditions matched those used for the industrial worker. This is consistent with the limitations on exposure under the current administrative controls, which will be continued through implementation of interim institutional controls of the selected alternative.

E.1.2.3 Recreational User

For the purposes of establishing RGOs for the recreational user under current site conditions, the teen recreational user scenario was used. The teen users are much more likely to be around the NSDD than either the child or adult users (DOE 2006). For the establishment of realistic RGOs, the teen user was assumed to spend an average of 42 days during the summer months in the areas around the NSDD and 18 days in the fall and winter during hunting season. An average daily exposure was assumed to remain constant at 5 hrs/day. Assuming relatively little clothing during the summer and almost completely clothed during the fall and winter, an average dermal exposure surface area of 0.74 m^2/day was calculated. The average daily ingestion rate of 100 mg/day was retained.

The RGOs protective of the industrial worker and recreational user under the most likely rates of exposure are presented in Tables E.1–E.4.

Table E.1. Cancer Risk RGOs for the Industrial Worker and Recreational User under Most Likely Exposure Scenarios

	Industrial Worker[b]			Recreational User[c]		
	Risk = 10^{-4}	Risk = 10^{-5}	Risk = 10^{-6}	Risk = 10^{-4}	Risk = 10^{-5}	Risk = 10^{-6}
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)						
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	5.48E+02	5.48E+01	5.48E+00	1.81E+02	1.81E+01	1.81E+00
Beryllium	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]
Cadmium	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	NA	NA
Organic Compounds (mg/kg in Soil/Sediment)						
Total PCB	3.19E+02	3.19E+01	3.19E+00	6.44E+01	6.44E+00	6.44E-01
Total PAH (as BaPE)	5.43E+01	5.43E+00	5.43E-01	6.69E+00	6.69E-01	6.69E-02
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	2.30E+03	2.30E+02	2.30E+01	8.11E+03	8.11E+02	8.11E+01
Cesium-137	1.52E+02	1.52E+01	1.52E+00	1.19E+02	1.19E+01	1.19E+00
Cobalt-60	3.15E+01	3.15E+00	3.15E-01	2.45E+01	2.45E+00	2.45E-01
Neptunium-237	4.33E+02	4.33E+01	4.33E+00	3.78E+02	3.78E+01	3.78E+00
Plutonium-239/240	2.15E+03	2.15E+02	2.15E+01	2.37E+04	2.37E+03	2.37E+02
Technetium-99	7.65E+04	7.65E+03	7.65E+02	7.06E+05	7.06E+04	7.06E+03
Thorium-230	2.93E+03	2.93E+02	2.93E+01	3.02E+04	3.02E+03	3.02E+02
Thorium-232	2.57E+03	2.57E+02	2.57E+01	2.79E+04	2.79E+03	2.79E+02
Uranium-234	3.76E+03	3.76E+02	3.76E+01	4.07E+04	4.07E+03	4.07E+02
Uranium-235	6.05E+02	6.05E+01	6.05E+00	5.53E+02	5.53E+01	5.53E+00
Uranium-238	1.88E+03	1.88E+02	1.88E+01	2.46E+03	2.46E+02	2.46E+01

[a]Screening values greater than 100,000 mg/kg are reported as >1E+5 as required in Appendix A of the Risk Methods Document.
[b]Industrial worker risk values were derived using the following exposure parameters: exposure frequency =14 d/yr; exposure duration=25 yr; ingestion rate=480 mg/d; absorption factor=0.001 except where chemical specific information was available; and surface area=0.193m^2. Default parameters from the Risk Methods Document were used for all other parameters.
[c]Teen recreational risk values were derived using the following exposure parameters: exposure frequency=60 d/yr; exposure duration=12 yr; ingestion rate=100 mg/d; absorption factor=0.001 except where chemical specific information was available; and surface area=0.74 m^2. Default parameters from the Risk Methods Document were used for all other parameters.
Slope factors used are shown in Table E.19.

Table E.2. HI RGOs for the Industrial Worker and Recreational User under Most Likely Exposure Scenarios

COC	Industrial Worker[a]		Recreational User[b]	
	HI = 0.1	HI = 1	HI = 0.1	HI = 1
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]
Antimony	1.27E+02	1.27E+03	2.68E+01	2.68E+02
Arsenic	8.81E+01	8.81E+02	1.40E+01	1.40E+02
Beryllium	5.42E+02	5.42E+03	6.87E+01	6.87E+02
Cadmium	2.71E+02	2.71E+03	3.44E+01	3.44E+02
Iron	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]	>1E+05 [a]
Manganese	4.78E+04	>1E+05 [a]	1.75E+04	>1E+05 [a]
Nickel	7.49E+03	7.49E+04	1.08E+04	>1E+05 [a]
Uranium	2.27E+02	2.27E+03	5.31E+02	5.31E+03
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	NA	NA	NA	NA
Total PAH (as BaPE)	NA	NA	NA	NA
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA
Neptunium-237	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA
Technetium-99	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA
Uranium-234	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA
Uranium-238	NA	NA	NA	NA

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5 as required in Appendix A of the Risk Methods Document.

[b]Industrial worker hazard values were derived using the following exposure parameters: exposure frequency=14 d/yr; exposure duration=25 yr; ingestion rate=480 mg/d; absorption factor=0.001 except where chemical specific information was available; and surface area=0.193 m^2. Default parameters from the Risk Methods Document were used for all other parameters.

[c]Teen recreational hazard values were derived using the following exposure parameters: exposure frequency=60 d/yr; exposure duration=12 yr; ingestion rate=100 mg/d; absorption factor=0.001 except where chemical specific information was available; and surface area=0.74 m^2. Default parameters from the Risk Methods Document were used for all other parameters.

Reference dose values used are shown in Table E.20.

Table E.3. Dose-based Soil/Sediment RGOs for Industrial Worker

Radionuclide	Units	Industrial Worker		
		1 mrem/yr	15 mrem/yr	25 mrem/yr
Americium-241	pCi/g	4.01E+01	6.02E+02	1.00E+03
Cesium-137	pCi/g	2.84E+01	4.26E+02	7.10E+02
Cobalt-60	pCi/g	6.03E+00	9.04E+01	1.51E+02
Neptunium-237+D	pCi/g	2.43E+01	3.65E+02	6.08E+02
Plutonium-238	pCi/g	4.65E+01	6.97E+02	1.16E+03
Plutonium-239/240	pCi/g	4.20E+01	6.30E+02	1.05E+03
Technetium-99	pCi/g	9.01E+04	1.35E+06	2.25E+06
Thorium-230	pCi/g	2.71E+02	4.06E+03	6.76E+03
Thorium-232	pCi/g	5.45E+01	8.17E+02	1.36E+03
Uranium-234	pCi/g	5.24E+02	7.87E+03	1.31E+04
Uranium-235+D	pCi/g	1.05E+02	1.57E+03	2.62E+03
Uranium-238+D	pCi/g	3.21E+02	4.81E+03	8.02E+03

Values were calculated using dose conversion factors from RESRAD 6.3.

Table E.4. Dose-based Soil/Sediment RGOs for Recreational Users

Radionuclide	Units	Revised Recreational Users		
		1 mrem/yr	15 mrem/yr	25 mrem/yr
Americium-241	pCi/g	4.35E+01	6.52E+02	1.09E+03
Cesium-137	pCi/g	1.07E+01	1.60E+02	2.67E+02
Cobalt-60	pCi/g	2.25E+00	3.38E+01	5.63E+01
Neptunium-237+D	pCi/g	1.76E+01	2.64E+02	4.40E+02
Plutonium-238	pCi/g	5.20E+01	7.81E+02	1.30E+03
Plutonium-239/240	pCi/g	4.70E+01	7.06E+02	1.18E+03
Technetium-99	pCi/g	8.19E+04	1.23E+06	2.05E+06
Thorium-230	pCi/g	3.01E+02	4.51E+03	7.51E+03
Thorium-232	pCi/g	6.09E+01	9.13E+02	1.52E+03
Uranium-234	pCi/g	5.84E+02	8.76E+03	1.46E+04
Uranium-235+D	pCi/g	4.48E+01	6.71E+02	1.12E+03
Uranium-238+D	pCi/g	1.89E+02	2.84E+03	4.73E+03

Values were calculated using dose conversion factors from RESRAD 6.3.

E.1.3 Human Health Risk Uncertainties

The following sections outline some of the uncertainties identified while performing the human health risk assessment. The uncertainties are presented here to support the development of the RGOs used in the alternatives analysis.

E.1.3.1 Selection of Chemicals of Potential Concern

Uncertainty in the selection of chemicals of potential concern (COPCs) is derived primarily from the initial selection of COPCs. Chemicals detected in soil and sediment samples from the SWOU were selected only if they were identified in Table 5.1 of the Sampling and Analysis Plan for the SI/BRA of the SWOU (On-Site) (DOE 2005). Essential nutrients were eliminated from the list of COPCs and the final list of COPCs was developed by screening against residential no action levels presented in Appendix A of *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D2 (DOE 2001). In the SI/BRA, some chemicals were eliminated as COPCs based on frequency of detection or because they were not expected as a result of processes at the site. It should be noted that these chemicals have not been identified as significant risk drivers in past risk assessments for the site and are unlikely to be important for the overall risk management at the site. Since these chemicals may have been selected as COPCs in a traditional COPC screen, an additional screening analysis was performed on these chemicals to determine whether their inclusion in the risk assessment would affect the development of the RGOs. The following is a listing of the additional chemicals that may have been selected as COPCs in a traditional COPC screen and a summary of the additional screening analysis that was performed.

Chemical Name	Units	Maximum	Percent Detect	Residential No Action Level	Selected as a COPC?	Screening Analysis?
1,1-Dichloroethene	mg/kg	0.508	2%	0.0276	No	Yes
1,2-Diphenylhydrazine	mg/kg	0.5	14%	0.117	No	Yes
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	0.0000182	100%*	0.0000149	No	Yes
2,4-Dinitrotoluene	mg/kg	0.5	4%	0.209	No	Yes
2,6-Dinitrotoluene	mg/kg	0.5	4%	0.209	No	Yes
3,3'-Dichlorobenzidine	mg/kg	0.5	9%	0.208	No	Yes
Benzidine	mg/kg	0.5	10%	0.00059	No	Yes
Bis(2-chloroethyl) ether	mg/kg	0.5	7%	0.029	No	Yes
Carbazole	mg/kg	7.3	9%	6.14	No	Yes
Dieldrin	mg/kg	0.062	3%	0.0059	No	Yes
Hexachlorobenzene	mg/kg	0.5	8%	0.0585	No	Yes
Hexachlorobutadiene	mg/kg	0.5	8%	0.32	No	Yes
Nitrobenzene	mg/kg	0.5	6%	0.492	No	Yes
N-Nitrosodimethylamine	mg/kg	0.5	14%	0.0018	No	Yes
N-Nitroso-di-n-propylamine	mg/kg	0.5	6%	0.0073	No	Yes
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	0.0253	100%*	0.00149	No	Yes
Radium-226	pCi/g	2.51	4%	0.00382	No	Yes

While detected at frequencies greater than 5%, N-nitrosodimethylamine (NDMA) and n-dinitroso-di-n-propylamine are common disinfection byproducts. Neither is known to be part of plant operations or other routine processes conducted at PGDP, and these chemicals may be present as the result of releases of municipal water into the drainage system. Since these chemicals are not related specifically to plant operations, they are unlikely to be important for risk management for the site.

Bis(2-chloroethyl)ether, 1,1-dichlorethene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, dieldrin, radium-226, 1,2-diphenylhydrazine, 3,3'-dichlorobenzidine, benzidine, bis(2-chloroethyl)ether, carbazole, hexachlorobenzene, hexachlorobutadiene, and nitrobenzene were evaluated further in order to determine the impact that the selection of these 13 chemicals as COPCs might have on the development of site-specific RGOs for the SWOU EE/CA. Risk and hazard estimates based on the site-specific recreational teen exposure parameters were generated for each of the 13 chemicals and compared with target and hazard goals. The site-specific recreational teen was used in this evaluation, because the exposure scenarios used for the recreational teen result in a more conservative assessment of risk (i.e., less likely to underestimate risk and hazard under current use) than those for the site-specific industrial worker. To calculate the risk and ensure conservatism in the screening evaluation, the maximum detected concentration for each of the chemicals was used in the evaluation.

Bis(2-chloroethyl)ether was detected in 6% of soil and sediment samples at concentrations marginally above detection limits. The detection limit for this chemical was about an order of magnitude above its residential no action level; thus, it could have been selected as a COC under the residential scenario. The risk to the teen recreator under the site-specific exposure scenario is only 2.69×10^{-7}, well below the lower limit of the U.S. Environmental Protection Agency's (EPA) target risk range (i.e., 1×10^{-6} to 1×10^{-4}) and the target risk used to develop RGOs (i.e., 1×10^{-5}). Noncarcinogenic effects for bis(2-chloroethyl)ether could not be assessed because this chemical does not have a reference dose. Given bis(2-chloroethyl)ether's infrequent detection and low risk relative to chemicals and compounds driving risk in the Baseline Human Health Risk Assessment (BHHRA), bis(2-chloroethyl)ether would not be useful when targeting areas to be remediated.

1,1-Dichlorethene was detected in 2% of soil and sediment samples and could have been selected as a COC under the residential scenario; however, the risk to the teen recreator under the site-specific scenario is only 2.50×10^{-9}. This value is well below the lower limit of EPA's target risk range and the target risk used to develop RGOs. Noncarcinogenic effects for 1,1-dichlorethene could be assessed and equaled 0.00035 for the teen recreator under site-specific exposure. This hazard quotient is well below the target value of 0.1 used to develop RGOs. Given 1,1-dichlorethene's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, 1,1-dichlorethene would not be useful when targeting areas to be remediated.

2,4-Dinitrotoluene and 2,6-dinitrotoluene both were detected in 4% of soil and sediment samples and could have been selected as a COC under the residential scenario. Both chemicals had the same maximum detected concentration, and the risk to the teen recreator under the site-specific scenario from either 2, 4-dinitrotoluene or 2, 6-dinitrotoluene is 3.16×10^{-9}. Noncarcinogenic effects for 2, 4-dinitrotoluene could be assessed and equaled 0.00085 for the teen recreator under site-specific exposure. Noncarcinogenic effects for 2, 6-dinitrotoluene could be assessed and equaled 0.0017 for the teen recreator under site-specific exposure. Both these hazard quotients are well below the target value of 0.1 used to develop RGOs. Given the infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, neither of these chemicals would be useful when targeting areas to be remediated.

Dieldrin was detected in 3% of soil and sediment samples and could have been selected as a COC under the residential scenario; however, the risk to the teen recreator under the site-specific scenario is only 2.17×10^{-7}. This value is well below the lower limit of EPA's target risk range and the target risk used to develop RGOs. Noncarcinogenic effects for dieldrin could be assessed and equaled 0.007 for the teen recreator under site-specific exposure. This hazard quotient is well below the target value of 0.1 used to develop RGOs. Given dieldrin's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, dieldrin would not be useful when targeting areas to be remediated.

Radium-226 was detected in 4% of soil and sediment samples and could have been selected as a COC under the residential scenario; however, the risk to the teen recreator under the site-specific scenario is 7.03×10^{-6}. This risk results from the external exposure pathway and exceeds the *de minimis* level, but still is below the risks associated with the COCs that are risk drivers at the site. Considering the infrequent detection of radium-226 and its small contribution to total risk relative to chemicals and compounds driving risk in the BHHRA, radium-226 would not be useful when targeting areas to be remediated.

Carbazole also was detected in 9% of soil and sediment samples and could have been selected as a COC under the residential scenario; however, the risk to the teen recreator under the site-specific scenario is only 1.97×10^{-8}. This value is well below the lower limit of EPA's target risk range and the target risk used to develop RGOs. Noncarcinogenic effects for carbozole could not be assessed because this chemical does not have a reference dose. Given carbazole's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, carbazole would not be useful when targeting areas to be remediated.

Benzidine was detected in 10% of soil and sediment samples at concentrations close to its detection limit (approximately 0.50 mg/kg). All detected results were estimated based on poor surrogate recoveries. The detection limit for this chemical was approximately three orders of magnitude above the residential no action level; therefore, benzidine could have been selected as a COC under the residential scenario. However, the risk to the teen recreator under the site-specific exposure scenario is 1.56×10^{-5}. This value is within the EPA target risk range and similar to the target risk used to develop RGOs. Noncarcinogenic effects for benzidine could be assessed and equaled 0.00007 for the teen recreator under site-specific exposure. This hazard quotient is well below the target value of 0.1 used to develop RGOs. Given benzidine's infrequent and uncertain detection and low risk relative to chemicals and compounds driving risk in the BHHRA, benzidine would not be useful when targeting areas to be remediated.

Hexachlorobenzene was detected in 8% of soil and sediment samples at concentrations close to its detection limit (approximately 0.50 mg/kg). The detection limit for this chemical was an order of magnitude greater than the residential no action level; therefore, hexachlorobenzene could have been selected as a COC under the residential scenario. Like benzidine, hexachlorobenzene has both carcinogenic and noncarcinogenic effects, and the risk and hazard to the teen recreator under the site-specific exposure scenario were 4.31×10^{-7} and 0.0004, respectively. The risk estimate is well below the lower limit of the EPA target risk range and the target risk used to develop RGOs, and the hazard quotient is well below the target value used to develop RGOs. Given hexachlorobenzene's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, hexachlorobenzene would not be useful when targeting areas to be remediated.

Hexachlorobutadiene was detected in 8% of soil and sediment samples at concentrations above the detection limit and could have been selected as a COC under the residential scenario. Like benzidine and hexachlorobenzene, hexachlorobutadiene has both carcinogenic and noncarcinogenic effects, and the risk and hazard to the teen recreator under the site-specific exposure scenario were 7.05×10^{-8} and 0.0016, respectively. The risk estimate is well below the lower limit of the EPA target risk range and the target risk used to develop RGOs, and the hazard quotient is well below the target values used to develop RGOs. Given hexachlorobutadiene's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, hexachlorobutadiene would not be useful when targeting areas to be remediated.

Nitrobenzene was detected in 6% of soil and sediment samples at concentrations near the detection limit and only marginally above the residential no action level. Nitrobenzene could have been selected as a COC under the residential scenario. Nitrobenzene poses only a noncancer hazard and the hazard to the teen recreator under the site-specific exposure scenario was 0.0014. The hazard quotient is well below the target values used to develop RGOs; therefore, nitrobenzene would not be useful when targeting areas to be remediated.

1,2-Diphenylhydrazine and 3,3'-dichlorobenzidine were detected in 14% and 9% of soil and sediment samples, respectively, and could have been selected as COCs under the residential scenario. Both chemicals are known carcinogens and the risk to the teen recreator under the site-specific exposure scenario was 6.72×10^{-8} for 1,2-diphenylhydrazine and 3.88×10^{-8} for 3,3'-dichlorobenzidine, both well below the lower limit of EPA's target risk range and the target risk used to develop RGOs. Noncarcinogenic effects of 1,2-diphenylhydrazine and 3,3'-dichlorobenzidine could not be addressed because these chemicals do not have a reference dose. Given, 1,2-diphenylhydrazine's and 3,3'-dichlorobenzidine's infrequent detection and low risk relative to chemicals and compounds driving risk in the BHHRA, these chemical would not be useful when targeting areas to be remediated.

Dioxins/furans were not selected as COPCs for use in the BHHRA because limited characterization information is available for the PGDP outfalls and ditches. Two historical soil/sediment samples from Outfall 010 were analyzed for dioxins/furans. The maximum concentrations of the majority of the dioxins/furans analyzed are below the residential no action levels as presented in the Risk Methods Document (DOE 2001). Concentrations of 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin and octachlorodibenzo (b,e)(1,4)dioxin [OCDD], however, were detected above their respective screening levels and could have been selected as COCs under the residential scenario. Both chemicals are known carcinogens and the risk to the teen recreator under the site-specific exposure scenario is 1.83×10^{-8} for hexachlorodibenzo-p-dioxin and 1.35×10^{-6} for OCDD, below and similar to, the lower limit of EPA's target risk range. Both risk results are below the target risk used to develop RGOs. Noncarcinogenic effects of hexachlorodibenzo-p-dioxin and OCDD could not be addressed because these chemicals do not have a reference dose. These results indicate that dioxins would not be useful when targeting areas to be remediated.

In summary, while there is some uncertainty in the selection of COPCs based upon the initial selection process, chemicals not retained as COPCs and, possibly selected as COCs, are unlikely to contribute significantly to site-related cancer risks or noncancer hazards and would be of little use when targeting areas for remediation. Other COCs that are risk drivers and are used to target areas to be remediated are present at maximum concentrations ranging from several hundred to over 10,000 times higher than their respective no action levels.[11]

E.1.3.2 Dermal Contact

Dermal contact with soil was an important exposure route in previous BHHRAs at PGDP, with most of this risk arising from contact with metals in soil. This result arises from using dermal absorption factors (ABS values) that exceed gastrointestinal (GI) absorption values in the risk calculations. As noted in the SWOU (On-Site) SI/BRA report, (DOE 2006) using Kentucky Department for Environmental Protection (KDEP) default exposure assumptions contributes significantly to uncertainty in the BHHRA. To address this uncertainty, ABS values recommended by the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2004) were used in the derivation of RGOs when a chemical specific absorption factor was not available. In the case of metals without a chemical-specific value, an ABS value of 0.1%, taken from the action level calculations in the Risk Method document, was used in place of the KDEP default value of 5%. While using an ABS value of 0.1% is less conservative than using the KDEP default value, its use is more

[11] All COCs or other contaminants for which there is substantial uncertainty will be evaluated as part of future validation sampling activities as appropriate (e.g., Remedial Action Work Plan associated with SWOU).

conservative than guidance in EPA 2004. In EPA 2004, cadmium and arsenic were the only metals that had chemical-specific dermal absorption values, and this guidance suggested not assigning dermal absorption values to other metals. The use of an ABS value of 0.1% minimizes uncertainty.

E.1.3.3 Iron Exposure

Iron was identified as a COC at the NSDD, Hot Spot and the NSDD, Excluding the Hot Spot, based on contact with soil/sediment for the recreational exposure scenarios. Remedial decisions focused on iron may be inappropriate since iron likely is consistent with background values. All but one exposure point concentration (EPC) for iron were below the background concentration of 28,000 mg/kg. The single exception is a case where the maximum detected concentration was used as the EPC due to a statistical instability in the H-statistic calculation. Additionally, the derived oral reference dose (RfD) for iron is very conservative, further overestimating iron; therefore, iron is removed as a risk factor.

E.1.3.4 Detection Limits Associated with Antimony Analytical Results

There is uncertainty associated with the antimony analytical results, as all of the detected concentrations were reported either at or slightly above the detection limits. The detection limits also were high, likely due to matrix interferences at concentrations ranging from 8.41 mg/kg to 9.97 mg/kg (assumed to be a 1X dilution) or at 20 mg/kg (assumed to be a 2X dilution). Comparatively, the detected concentrations ranged from 8.41 mg/kg to 9.99 mg/kg or a value of exactly 20 mg/kg. The average concentration calculated with detected concentrations only (238 results) was 10.4 mg/kg, and the average concentration calculated using both detected and nondetected concentrations using full detection limits (433 results) was 10.8 mg/kg. Collectively, these results indicate that the detected and the nondetected results virtually were indistinguishable; therefore, there is a high degree of uncertainty as to whether the antimony results from soil/sediment samples that are driving hazard risk are truly representative of actual detected concentrations in soil/sediment. In addition, since previously documented sampling results using more stringent analytical methods failed to detect antimony above the 0.21 mg/kg level (DOE 1997b), it is reasonable to remove antimony as a risk factor.

E.1.4 Observations

E.1.4.1 PAHs as Risk Drivers

The identification of total polycyclic aromatic hydrocarbon compounds (PAHs) as risk drivers in soil at several EUs for industrial workers agrees with previous PGDP risk assessments; however, the significance of this finding should be considered along with the sources previously and currently identified at PGDP. There are no known primary sources of PAHs at the site, and their presence is believed to be attributed to ongoing activities associated with routine industrial activities (e.g., motorized vehicles, asphalt paving, etc.). As a result, PAHs are not good candidates to verify cleanup as part of this interim action. For this interim action, other primary contaminants of concern (COCs) such as polychlorinated biphenyls (PCBs) and uranium will be used to verify cleanup. It is anticipated that removal of hotspots for these primary COCs will provide opportunities to achieve significant human and ecological risk reduction associated with PAHs.

E.1.5 Comparison of RGOs to COCs for the Industrial Worker

A comparison of the potential RGOs for risk, hazard, and dose identified in Tables E.1 through E.4 to the concentrations of the COCs within the individual on-site EUs, as identified in Sections 1.4 and 1.7, was completed to determine any exceedances of the potential RGOs of risk, hazard, or dose for the industrial worker. This information is summarized in Tables E.5 through E.9. Tables E.5 and E.6 illustrate the

COCs that exceed an HI of 0.1 and 1.0, respectively. Uranium metal exhibits an HI > 0.1 at Outfall 011 Hot Spot , Outfall 015 Hot Spot, and Outfall 001 EU 15 Hot Spot. It should be noted that no COCs were found to exceed an HI of 3.0.

Tables E.7 though E.9 illustrate the COCs that exceed an ELCR of 1E-6, 1E-5, and 1E-4, respectively. Cesium-137, plutonium-239/240, thorium-230, uranium-238, Total PAH (as BaPE), Total PCB, and arsenic exhibit an ELCR >1E-6. Specifically, cesium-137 exhibited an ELCR >1E-6 at Outfall 015 Hot Spot and Outfall 001 EU 018 Hot Spot; plutonium-239/240 exhibited an ELCR >1E-6 at Outfall 015 Hot Spot; thorium-230 exhibited an ELCR >1E-6 at Outfall 008 Hot Spot; uranium-238 exhibited an ELCR >1E-6 at Outfall 015 Hot Spot; Total PAH exhibited an ELCR >1E-6 at all EUs (Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 015 Hot Spot, Outfall 001 EU 13 Hot Spot, Outfall 001 EU 14 Hot Spot, Outfall 001 EU 15 Hot Spot, Outfall 001 EU 16 Hot Spot, Outfall 001 EU 18 Hot Spot, Outfall 001 EU 20 Hot Spot, and Within the Fence, Excluding the Hot Spot); Total PCB exhibit an ELCR >1E-6 at Outfall 008 Hot Spot, Outfall 010 Hot Spot, Outfall 011 Hot Spot, Outfall 001 EU 13 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU15 Hot Spot; and arsenic exhibited an ELCR >1E-6 at all EUs except Outfall 001 EU 13 Hot Spot, Outfall 001 EU 14 Hot Spot, and Outfall 001 EU 18 Hot Spot. It should be noted, however, that the arsenic levels exceed the background concentration only at Outfall 010 Hot Spot and Outfall 011 Hot Spot. Cesium-137, Total PAH (as BaPE), and Total PCB were the only COCs that exhibited an ELCR >1E-5. Specifically, cesium-137 exhibited an ELCR >1E-5 at Outfall 015 Hot Spot. Total PAH (as BaPE) exhibited an ELCR >1E-5 at Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot. Total PCB exhibited an ELCR >1E-5 at Outfall 008 Hot Spot and Outfall 001 EU 15 Hot Spot. Total PAH (as BaPE) was the only COC to exceed an ELCR of 1E-4 at Outfall 011 Hot Spot and Outfall 001 EU 14 Hot Spot. As previously noted in Section E.1.4.1, “Other Contaminants of Concern,” PAHs currently are not targeted to direct cleanup as part of this action.

No COCs had a concentration that exceeded either the 25 mrem/yr-based cleanup level or a lower 15 mrem/yr-based value for any of the outfalls.

Table E.5. Comparison of EPCs to RGOs for a HI of 0.1 for the Industrial Worker

COC	RGO (HI= 0.1)	Background Soil Conc.	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Within the Fence, Excluding the Hot Spots
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)													
Aluminum	>1E+05[a]	1.3E+04	9.1E+03	1.3E+04	1.0E+04	6.7E+03	8.9E+03	8.2E+03	7.5E+03	8.2E+03	1.2E+04	9.0E+03	7.2E+03
Antimony	1.3E+02	2.1E-01	9.7E+00	9.7E+00	1.7E+01	1.1E+01	9.9E+00	1.5E+01	9.8E+00	9.6E+00	9.9E+00	9.7E+00	1.1E+01
Arsenic	8.8E+01	1.2E+01	5.7E+00	1.3E+01	1.3E+01	1.0E+01	5.2E+00	5.0E+00	9.6E+00	1.1E+01	4.7E+00	6.8E+00	6.0E+00
Beryllium	5.4E+02	6.7E-01	5.3E-01	4.8E-01	9.6E-01	5.7E-01	9.1E+01	4.8E-01	ND	6.6E-01	6.0E-01	ND	5.2E-01
Cadmium	2.7E+02	2.1E-01	ND	ND	2.8E+00	2.1E+00	ND	1.9E+00	2.8E+00	1.9E+01	ND	ND	3.6E+00
Iron	>1E+05[a]	2.8E+04	1.2E+04	1.6E+04	2.3E+04	1.5E+04	1.5E+04	1.2E+04	1.2E+04	1.8E+05	1.6E+04	1.1E+04	1.1E+04
Manganese	4.8E+04	1.5E+03	4.7E+02	3.2E+02	6.0E+02	5.3E+02	7.9E+02	3.4E+02	3.4E+02	1.5E+03	8.5E+02	4.7E+02	3.5E+02
Nickel	7.5E+03	2.1E+01	1.7E+01	2.2E+01	1.4E+01	2.9E+01	1.3E+01	1.6E+01	5.2E+02	1.0E+01	1.8E+02	7.2E+00	9.9E+00
Uranium	2.3E+02	4.9E+00	9.6E+01	2.6E+01	4.4E+02	9.2E+02	4.9E+01	7.8E+00	6.4E+02	1.4E+01	9.1E+01	1.9E+01	2.1E+02
Organic Compounds (mg/kg in Soil/Sediment)													
Total PCB	NA	NA	3.2E+01	1.9E+01	7.6E+00	1.1E+00	3.3E+00	2.2E+01	5.2E+01	1.8E+00	1.5E+00	7.1E-01	6.3E-01
Total PAH (as BaPE)	NA	NA	1.2E+00	3.1E+00	5.8E+01	1.1E+00	1.1E+00	1.8E+02	5.2E+00	1.4E+00	1.1E+00	1.1E+00	1.0E+00
Radionuclides (pCi/g in Soil/Sediment)													
Americium-241	NA	NA	1.0E+00	ND	ND	5.6E-01	ND	ND	1.3E-01	ND	5.2E-01	6.1E-02	2.0E-01
Cesium-137	NA	4.9E-01	5.5E-01	7.3E-01	5.4E-01	3.1E+01	3.0E-01	1.2E-01	6.8E-01	1.8E-01	9.4E+00	2.8E-01	4.3E-01
Cobalt-60	NA	NA	ND	ND	ND	1.8E-01	ND	ND	ND	ND	ND	ND	1.4E-01
Neptunium-237	NA	1.0E-01	6.6E-01	6.4E-02	ND	4.2E-01	6.0E-01	6.8E-02	3.4E-01	7.0E-02	2.9E+00	5.2E-01	6.5E-02
Plutonium-239/240	NA	2.5E-02	9.1E+00	1.1E-01	4.6E-02	2.7E+01	7.0E-02	7.9E-02	6.3E-01	5.7E-02	3.6E+00	4.0E-01	5.0E-02
Technetium-99	NA	2.5E+00	7.4E+00	8.4E+00	7.5E+00	2.1E+01	1.0E+01	4.7E+00	3.7E+01	6.1E+00	2.3E+02	6.2E+00	5.9E+00
Thorium-230	NA	1.5E+00	8.4E+01	8.2E-01	1.1E+00	1.6E+01	3.0E+00	1.8E+00	4.3E+00	6.6E-01	1.2E+01	4.3E+00	7.7E-01
Thorium-232	NA	1.5E+00	6.7E-01	2.7E-01	5.0E-01	5.5E-01	4.5E-01	4.4E-01	3.5E-01	2.0E-01	3.9E-01	6.6E-01	3.3E-01
Uranium-234	NA	2.5E+00	3.1E+00	7.4E+00	3.1E+00	6.1E+00	4.4E+00	2.0E+00	1.1E+01	7.3E-01	2.5E+00	3.7E+00	1.4E+00
Uranium-235	NA	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9E+00
Uranium-238	NA	1.2E+00	4.6E+00	8.8E+00	1.7E+01	3.3E+01	1.6E+01	2.6E+00	1.2E+01	2.0E+00	1.3E+01	4.3E+00	3.7E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

The RGO was exceeded for these compounds at these locations.

Table E.6. Comparison of EPCs to RGOs for a HI of 1.0 for the Industrial Worker

COC	RGO (HI =1.0)	Background Soil Conc.	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Within the Fence, Excluding the Hot Spots
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)													
Aluminum	>1E+05 [a]	1.3E+04	9.1E+03	1.3E+04	1.0E+04	6.7E+03	8.9E+03	8.2E+03	7.5E+03	8.2E+03	1.2E+04	9.0E+03	7.2E+03
Antimony	1.3E+03	2.1E-01	9.7E+00	9.7E+00	1.7E+01	1.1E+01	9.9E+00	1.5E+01	9.8E+00	9.6E+00	9.9E+00	9.7E+00	1.1E+01
Arsenic	8.8E+02	1.2E+01	5.7E+00	1.3E+01	1.3E+01	1.0E+01	5.2E+00	5.0E+00	9.6E+00	1.1E+01	4.7E+00	6.8E+00	6.0E+00
Beryllium	5.4E+03	6.7E-01	5.3E-01	4.8E-01	9.6E-01	5.7E-01	9.1E+01	4.8E-01	ND	6.6E-01	6.0E-01	ND	5.2E-01
Cadmium	2.7E+03	2.1E-01	ND	ND	2.8E+00	2.1E+00	ND	1.9E+00	2.8E+00	1.9E+01	ND	ND	3.6E+00
Iron	>1E+05 [a]	2.8E+04	1.2E+04	1.6E+04	2.3E+04	1.5E+04	1.5E+04	1.2E+04	1.2E+04	1.8E+05	1.6E+04	1.1E+04	1.1E+04
Manganese	>1E+05 [a]	1.5E+03	4.7E+02	3.2E+02	6.0E+02	5.3E+02	7.9E+02	3.4E+02	3.4E+02	1.5E+03	8.5E+02	4.7E+02	3.5E+02
Nickel	7.5E+04	2.1E+01	1.7E+01	2.2E+01	1.4E+01	2.9E+01	1.3E+01	1.6E+01	5.2E+02	1.0E+01	1.8E+02	7.2E+00	9.9E+00
Uranium	2.3E+03	4.9E+00	9.6E+01	2.6E+01	4.4E+02	9.2E+02	4.9E+01	7.8E+00	6.4E+02	1.4E+01	9.1E+01	1.9E+01	2.1E+02
Organic Compounds (mg/kg in Soil/Sediment)													
Total PCB	NA	NA	3.2E+01	1.9E+01	7.6E+00	1.1E+00	3.3E+00	2.2E+01	5.2E+01	1.8E+00	1.5E+00	7.1E-01	6.3E-01
Total PAH (as BaPE)	NA	NA	1.2E+00	3.1E+00	5.8E+01	1.1E+00	1.1E+00	1.8E+02	5.2E+00	1.4E+00	1.1E+00	1.1E+00	1.0E+00
Radionuclides (pCi/g in Soil/Sediment)													
Americium-241	NA	NA	1.0E+00	ND	ND	5.6E-01	ND	ND	1.3E-01	ND	5.2E-01	6.1E-02	2.0E-01
Cesium-137	NA	4.9E-01	5.5E-01	7.3E-01	5.4E-01	3.1E+01	3.0E-01	1.2E-01	6.8E-01	1.8E-01	9.4E+00	2.8E-01	4.3E-01
Cobalt-60	NA	NA	ND	ND	ND	1.8E-01	ND	ND	ND	ND	ND	ND	1.4E-01
Neptunium-237	NA	1.0E-01	6.6E-01	6.4E-02	ND	4.2E-01	6.0E-01	6.8E-02	3.4E-01	7.0E-02	2.9E+00	5.2E-01	6.5E-02
Plutonium-239/240	NA	2.5E-02	9.1E+00	1.1E-01	4.6E-02	2.7E+01	7.0E-02	7.9E-02	6.3E-01	5.7E-02	3.6E+00	4.0E-01	5.0E-02
Technetium-99	NA	2.5E+00	7.4E+00	8.4E+00	7.5E+00	2.1E+01	1.0E+01	4.7E+00	3.7E+01	6.1E+00	2.3E+02	6.2E+00	5.9E+00
Thorium-228	NA	1.6E+00	5.9E-01	3.3E-01	4.8E-01	5.1E-01	3.5E-01	3.9E-01	3.2E-01	ND	3.5E-01	6.3E-01	3.2E-01
Thorium-230	NA	1.5E+00	8.4E+01	8.2E-01	1.1E+00	1.6E+01	3.0E+00	1.8E+00	4.3E+00	6.6E-01	1.2E+01	4.3E+00	7.7E-01
Thorium-232	NA	1.5E+00	6.7E-01	2.7E-01	5.0E-01	5.5E-01	4.5E-01	4.4E-01	3.5E-01	2.0E-01	3.9E-01	6.6E-01	3.3E-01
Uranium-234	NA	2.5E+00	3.1E+00	7.4E+00	3.1E+00	6.1E+00	4.4E+00	2.0E+00	1.1E+01	7.3E-01	2.5E+00	3.7E+00	1.4E+00
Uranium-235	NA	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9E+00
Uranium-238	NA	1.2E+00	4.6E+00	8.8E+00	1.7E+01	3.3E+01	1.6E+01	2.6E+00	1.2E+01	2.0E+00	1.3E+01	4.3E+00	3.7E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

Table E.7. Comparison of EPCs to RGOs for a ELCR of 1E-6 for the Industrial Worker

COC	RGO (ELCR =1E-6)	Background Soil Conc.	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Within the Fence, Excluding the Hot Spots
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)													
Aluminum	NA	1.3E+04	9.1E+03	1.3E+04	1.0E+04	6.7E+03	8.9E+03	8.2E+03	7.5E+03	8.2E+03	1.2E+04	9.0E+03	7.2E+03
Antimony	NA	2.1E-01	9.7E+00	9.7E+00	1.7E+01	1.1E+01	9.9E+00	1.5E+01	9.8E+00	9.6E+00	9.9E+00	9.7E+00	1.1E+01
Arsenic	5.48E+00	1.2E+01	**5.7E+00**	1.3E+01	1.3E+01	**1.0E+01**	5.2E+00	5.0E+00	**9.6E+00**	**1.1E+01**	4.7E+00	**6.8E+00**	**6.0E+00**
Beryllium	>1E+05[a]	6.7E-01	5.3E-01	4.8E-01	9.6E-01	5.7E-01	9.1E+01	4.8E-01	ND	6.6E-01	6.0E-01	ND	5.2E-01
Cadmium	NA	2.1E-01	ND	ND	2.8E+00	2.1E+00	ND	1.9E+00	2.8E+00	1.9E+01	ND	ND	3.6E+00
Iron	NA	2.8E+04	1.2E+04	1.6E+04	2.3E+04	1.5E+04	1.5E+04	1.2E+04	1.2E+04	1.8E+05	1.6E+04	1.1E+04	1.1E+04
Manganese	NA	1.5E+03	4.7E+02	3.2E+02	6.0E+02	5.3E+02	7.9E+02	3.4E+02	3.4E+02	1.5E+03	8.5E+02	4.7E+02	3.5E+02
Nickel	NA	2.1E+01	1.7E+01	2.2E+01	1.4E+01	2.9E+01	1.3E+01	1.6E+01	5.2E+02	1.0E+01	1.8E+02	7.2E+00	9.9E+00
Uranium	NA	4.9E+00	9.6E+01	2.6E+01	4.4E+02	9.2E+02	4.9E+01	7.8E+00	6.4E+02	1.4E+01	9.1E+01	1.9E+01	2.1E+02
Organic Compounds (mg/kg in Soil/Sediment)													
Total PCB	3.19E+00	NA	3.2E+01	1.9E+01	7.6E+00	1.1E+00	3.3E+00	2.2E+01	5.2E+01	1.8E+00	1.5E+00	7.1E-01	6.3E-01
Total PAH (as BaPE)	5.43E-01	NA	1.2E+00	3.1E+00	5.8E+01	1.1E+00	1.1E+00	1.8E+02	5.2E+00	1.4E+00	1.1E+00	1.1E+00	1.0E+00
Radionuclides (pCi/g in Soil/Sediment)													
Americium-241	2.30E+01	NA	1.0E+00	ND	ND	5.6E-01	ND	ND	1.3E-01	ND	5.2E-01	6.1E-02	2.0E-01
Cesium-137	1.52E+00	4.9E-01	5.5E-01	7.3E-01	5.4E-01	3.1E+01	3.0E-01	1.2E-01	6.8E-01	1.8E-01	9.4E+00	2.8E-01	4.3E-01
Cobalt-60	3.15E-01	NA	ND	ND	ND	1.8E-01	ND	ND	ND	ND	ND	ND	1.4E-01
Neptunium-237	4.33E+00	1.0E-01	6.6E-01	6.4E-02	ND	4.2E-01	6.0E-01	6.8E-02	3.4E-01	7.0E-02	2.9E+00	5.2E-01	6.5E-02
Plutonium-239/240	2.15E+01	2.5E-02	9.1E+00	1.1E-01	4.6E-02	2.7E+01	7.0E-02	7.9E-02	6.3E-01	5.7E-02	3.6E+00	4.0E-01	5.0E-02
Technetium-99	7.65E+02	2.5E+00	7.4E+00	8.4E+00	7.5E+00	2.1E+01	1.0E+01	4.7E+00	3.7E+01	6.1E+00	2.3E+02	6.2E+00	5.9E+00
Thorium-230	2.93E+01	1.5E+00	8.4E+01	8.2E-01	1.1E+00	1.6E+01	3.0E+00	1.8E+00	4.3E+00	6.6E-01	1.2E+01	4.3E+00	7.7E-01
Thorium-232	2.57E+01	1.5E+00	6.7E-01	2.7E-01	5.0E-01	5.5E-01	4.5E-01	4.4E-01	3.5E-01	2.0E-01	3.9E-01	6.6E-01	3.3E-01
Uranium-234	3.76E+01	2.5E+00	3.1E+00	7.4E+00	3.1E+00	6.1E+00	4.4E+00	2.0E+00	1.1E+01	7.3E-01	2.5E+00	3.7E+00	1.4E+00
Uranium-235	6.05E+00	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9E+00
Uranium-238	1.88E+01	1.2E+00	4.6E+00	8.8E+00	1.7E+01	3.3E+01	1.6E+01	2.6E+00	1.2E+01	2.0E+00	1.3E+01	4.3E+00	3.7E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.
The RGO was exceeded for these compounds at these locations, but was less than the background concentration.
The RGO was exceeded for these compounds at these locations.

Table E.8. Comparison of EPCs to RGOs for a ELCR of 1E-5 for the Industrial Worker

COC	RGO (ELCR = 1E-5)	Background Soil Conc.	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Within the Fence, Excluding the Hot Spots
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)													
Aluminum	NA	1.3E+04	9.1E+03	1.3E+04	1.0E+04	6.7E+03	8.9E+03	8.2E+03	7.5E+03	8.2E+03	1.2E+04	9.0E+03	7.2E+03
Antimony	NA	2.1E-01	9.7E+00	9.7E+00	1.7E+01	1.1E+01	9.9E+00	1.5E+01	9.8E+00	9.6E+00	9.9E+00	9.7E+00	1.1E+01
Arsenic	5.48E+01	1.2E+01	5.7E+00	1.3E+01	1.3E+01	1.0E+01	5.2E+00	5.0E+00	9.6E+00	1.1E+01	4.7E+00	6.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	5.3E-01	4.8E-01	9.6E-01	5.7E-01	9.1E+01	4.8E-01	ND	6.6E-01	6.0E-01	ND	5.2E-01
Cadmium	NA	2.1E-01	ND	ND	2.8E+00	2.1E+00	ND	1.9E+00	2.8E+00	1.9E+01	ND	ND	3.6E+00
Iron	NA	2.8E+04	1.2E+04	1.6E+04	2.3E+04	1.5E+04	1.5E+04	1.2E+04	1.2E+04	1.8E+05	1.6E+04	1.1E+04	1.1E+04
Manganese	NA	1.5E+03	4.7E+02	3.2E+02	6.0E+02	5.3E+02	7.9E+02	3.4E+02	3.4E+02	1.5E+03	8.5E+02	4.7E+02	3.5E+02
Nickel	NA	2.1E+01	1.7E+01	2.2E+01	1.4E+01	2.9E+01	1.3E+01	1.6E+01	5.2E+02	1.0E+01	1.8E+02	7.2E+00	9.9E+00
Uranium	NA	4.9E+00	9.6E+01	2.6E+01	4.4E+02	9.2E+02	4.9E+01	7.8E+00	6.4E+02	1.4E+01	9.1E+01	1.9E+01	2.1E+02
Organic Compounds (mg/kg in Soil/Sediment)													
Total PCB	3.19E+01	NA	3.2E+01	1.9E+01	7.6E+00	1.1E+00	3.3E+00	2.2E+01	5.2E+01	1.8E+00	1.5E+00	7.1E-01	6.3E-01
Total PAH (as BaPE)	5.43E+00	NA	1.2E+00	3.1E+00	5.8E+01	1.1E+00	1.1E+00	1.8E+02	5.2E+00	1.4E+00	1.1E+00	1.1E+00	1.0E+00
Radionuclides (pCi/g in Soil/Sediment)													
Americium-241	2.30E+02	NA	1.0E+00	ND	ND	5.6E-01	ND	ND	1.3E-01	ND	5.2E-01	6.1E-02	2.0E-01
Cesium-137	1.52E+01	4.9E-01	5.5E-01	7.3E-01	5.4E-01	3.1E+01	3.0E-01	1.2E-01	6.8E-01	1.8E-01	9.4E+00	2.8E-01	4.3E-01
Cobalt-60	3.15E+00	NA	ND	ND	ND	1.8E-01	ND	ND	ND	ND	ND	ND	1.4E-01
Neptunium-237	4.33E+01	1.0E-01	6.6E-01	6.4E-02	ND	4.2E-01	6.0E-01	6.8E-02	3.4E-01	7.0E-02	2.9E+00	5.2E-01	6.5E-02
Plutonium-239/240	2.15E+02	2.5E-02	9.1E+00	1.1E-01	4.6E-02	2.7E+01	7.0E-02	7.9E-02	6.3E-01	5.7E-02	3.6E+00	4.0E-01	5.0E-02
Technetium-99	7.65E+03	2.5E+00	7.4E+00	8.4E+00	7.5E+00	2.1E+01	1.0E+01	4.7E+00	3.7E+01	6.1E+00	2.3E+02	6.2E+00	5.9E+00
Thorium-230	2.93E+02	1.5E+00	8.4E+01	8.2E-01	1.1E+00	1.6E+01	3.0E+00	1.8E+00	4.3E+00	6.6E-01	1.2E+01	4.3E+00	7.7E-01
Thorium-232	2.57E+02	1.5E+00	6.7E-01	2.7E-01	5.0E-01	5.5E-01	4.5E-01	4.4E-01	3.5E-01	2.0E-01	3.9E-01	6.6E-01	3.3E-01
Uranium-234	3.76E+02	2.5E+00	3.1E+00	7.4E+00	3.1E+00	6.1E+00	4.4E+00	2.0E+00	1.1E+01	7.3E-01	2.5E+00	3.7E+00	1.4E+00
Uranium-235	6.05E+01	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9E+00
Uranium-238	1.88E+02	1.2E+00	4.6E+00	8.8E+00	1.7E+01	3.3E+01	1.6E+01	2.6E+00	1.2E+01	2.0E+00	1.3E+01	4.3E+00	3.7E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

The RGO was exceeded for these compounds at these locations.

Table E.9. Comparison of EPCs to RGOs for a ELCR of 1E-4 for the Industrial Worker

COC	RGO (ELCR = 1E-4)	Background Soil Conc.	Outfall 008 Hot Spot	Outfall 010 Hot Spot	Outfall 011 Hot Spot	Outfall 015 Hot Spot	Outfall 001 EU 13 Hot Spot	Outfall 001 EU 14 Hot Spot	Outfall 001 EU 15 Hot Spot	Outfall 001 EU 16 Hot Spot	Outfall 001 EU 18 Hot Spot	Outfall 001 EU 20 Hot Spot	Within the Fence, Excluding the Hot Spots
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)													
Aluminum	NA	1.3E+04	9.1E+03	1.3E+04	1.0E+04	6.7E+03	8.9E+03	8.2E+03	6.7E+03	8.2E+03	1.2E+04	9.0E+03	7.2E+03
Antimony	NA	2.1E-01	9.7E+00	9.7E+00	1.7E+01	1.1E+01	9.9E+00	1.5E+01	1.1E+01	9.6E+00	9.9E+00	9.7E+00	1.1E+01
Arsenic	5.48E+02	1.2E+01	5.7E+00	1.3E+01	1.3E+01	1.0E+01	5.2E+00	5.0E+00	1.0E+01	1.1E+01	4.7E+00	6.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	5.3E-01	4.8E-01	9.6E-01	5.7E-01	9.1E+01	4.8E-01	5.7E-01	6.6E-01	6.0E-01	ND	5.2E-01
Cadmium	NA	2.1E-01	ND	ND	2.8E+00	2.1E+00	ND	1.9E+00	2.1E+00	1.9E+01	ND	ND	3.6E+00
Iron	NA	2.8E+04	1.2E+04	1.6E+04	2.3E+04	1.5E+04	1.5E+04	1.2E+04	1.5E+04	1.8E+05	1.6E+04	1.1E+04	1.1E+04
Manganese	NA	1.5E+03	4.7E+02	3.2E+02	6.0E+02	5.3E+02	7.9E+02	3.4E+02	5.3E+02	1.5E+03	8.5E+02	4.7E+02	3.5E+02
Nickel	NA	2.1E+01	1.7E+01	2.2E+01	1.4E+01	2.9E+01	1.3E+01	1.6E+01	2.9E+01	1.0E+01	1.8E+02	7.2E+00	9.9E+00
Uranium	NA	4.9E+00	9.6E+01	2.6E+01	4.4E+02	9.2E+02	4.9E+01	7.8E+00	9.2E+02	1.4E+01	9.1E+01	1.9E+01	2.1E+02
Organic Compounds (mg/kg in Soil/Sediment)													
Total PCB	3.19E+02	NA	3.2E+01	1.9E+01	7.6E+00	1.1E+00	3.3E+00	2.2E+01	5.2E+01	1.8E+00	1.5E+00	7.1E-01	6.3E-01
Total PAH (as BaPE)	5.43E+01	NA	1.2E+00	3.1E+00	5.8E+01	1.1E+00	1.1E+00	1.8E+02	5.2E+00	1.4E+00	1.1E+00	1.1E+00	1.0E+00
Radionuclides (pCi/g in Soil/Sediment)													
2.7E+03	2.30E+03	NA	1.0E+00	ND	ND	5.6E-01	ND	ND	1.3E-01	ND	5.2E-01	6.1E-02	2.0E-01
1.4E+04	1.52E+02	4.9E-01	5.5E-01	7.3E-01	5.4E-01	3.1E+01	3.0E-01	1.2E-01	6.8E-01	1.8E-01	9.4E+00	2.8E-01	4.3E-01
1.5E+04	3.15E+01	NA	ND	ND	ND	1.8E-01	ND	ND	ND	ND	ND	ND	1.4E-01
3.7E+03	4.33E+02	1.0E-01	6.6E-01	6.4E-02	ND	4.2E-01	6.0E-01	6.8E-02	3.4E-01	7.0E-02	2.9E+00	5.2E-01	6.5E-02
2.2E+03	2.15E+03	2.5E-02	9.1E+00	1.1E-01	4.6E-02	2.7E+01	7.0E-02	7.9E-02	6.3E-01	5.7E-02	3.6E+00	4.0E-01	5.0E-02
7.8E+04	7.65E+04	2.5E+00	7.4E+00	8.4E+00	7.5E+00	2.1E+01	1.0E+01	4.7E+00	3.7E+01	6.1E+00	2.3E+02	6.2E+00	5.9E+00
2.9E+03	2.93E+03	1.5E+00	8.4E+01	8.2E-01	1.1E+00	1.6E+01	3.0E+00	1.8E+00	4.3E+00	6.6E-01	1.2E+01	4.3E+00	7.7E-01
2.6E+03	2.57E+03	1.5E+00	6.7E-01	2.7E-01	5.0E-01	5.5E-01	4.5E-01	4.4E-01	3.5E-01	2.0E-01	3.9E-01	6.6E-01	3.3E-01
3.8E+03	3.76E+03	2.5E+00	3.1E+00	7.4E+00	3.1E+00	6.1E+00	4.4E+00	2.0E+00	1.1E+01	7.3E-01	2.5E+00	3.7E+00	1.4E+00
3.8E+03	6.05E+02	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.9E+00
4.2E+03	1.88E+03	1.2E+00	4.6E+00	8.8E+00	1.7E+01	3.3E+01	1.6E+01	2.6E+00	1.2E+01	2.0E+00	1.3E+01	4.3E+00	3.7E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

The RGO was exceeded at these locations for these compounds at these locations.

E.1.6 Comparison of RGOs to COCs for the Industrial Worker at the NSDD

A comparison of the potential RGOs for risk, hazard, and dose identified in Tables E.1 through E.4 to the concentrations of the COCs within the NSDD, Hot Spot and NSDD, Excluding the Hot Spot, as identified in Sections 1.4 and 1.7, was completed to determine any exceedances of the potential RGOs of risk, hazard, or dose for the industrial worker at the NSDD. This information is summarized in Tables E.10 and E.13. Tables E.10 and E.11 illustrate the COCs that exceed an HI of 0.1 and 1.0, respectively. Uranium exhibits an HI >0.1 at the NSDD, Hot Spot. No COCs were found to exceed an HI of 1.0 or 3.0.

Tables E.12 and E.13 illustrate the COCs that exceed an ELCR of 1E-6 and 1E-5, respectively. Arsenic, Total PAH (as BaPE), and thorium-230 exhibited an ELCR >1E-6 at the NSDD Hot Spot and NSDD, Excluding the Hot Spot; however, it should be noted that the arsenic levels did not exceed background concentration. As previously noted in Section E.1.4.1, "Other Contaminants of Concern," PAHs currently are not targeted to direct cleanup as part of this action. Cesium-137, neptunium-237, and uranium-238 exhibited an ELCR >1E-6 at the NSDD, Hot Spot. Thorium-230 was the only COC to exhibit an ELCR >1E-5 at the NSDD Hot Spot. No other COCs were identified at an ELCR >1E-4 for the NSDD Hot Spot or NSDD, Excluding the Hot Spot.

No COCs had a concentration that exceeded either the 25 mrem/yr-based cleanup level or a lower 15 mrem/yr-based value for the NSDD Hot Spot or NSDD, Excluding the Hot Spot.

Table E.10. Comparison of EPCs to RGOs for a HI of 0.1 for the Industrial Worker at the NSDD

COC	RGO (HI =0.1)	Background Soil Conc.	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	>1E+05 [a]	1.3E+04	8.1E+03	6.4E+03
Antimony	1.3E+02	2.1E-01	1.4E+01	1.0E+01
Arsenic	8.8E+01	1.2E+01	5.8E+00	6.0E+00
Beryllium	5.4E+02	6.7E-01	6.5E-01	5.8E-01
Cadmium	2.7E+02	2.1E-01	ND	2.1E+00
Iron	>1E+05 [a]	2.8E+04	1.1E+04	9.3E+03
Manganese	4.8E+04	1.5E+03	4.2E+02	4.6E+02
Nickel	7.5E+03	2.1E+01	9.4E+01	1.6E+01
Uranium	2.3E+02	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	NA	NA	2.7E+00	1.1E+00
Total PAH (as (BaPE)	NA	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	NA	NA	4.4E+00	4.8E-01
Cesium-137	NA	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	NA	NA	ND	ND
Neptunium-237	NA	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	NA	2.5E-02	2.1E+01	4.8E+00
Technetium-99	NA	2.5E+00	6.0E+02	3.2E+01
Thorium-228	NA	1.6E+00	2.0E+00	4.7E-01
Thorium-230	NA	1.5E+00	5.0E+02	6.7E+01
Thorium-232	NA	1.5E+00	2.4E+00	5.6E-01
Uranium-234	NA	2.5E+00	2.9E+01	3.0E+00
Uranium-235	NA	1.4E-01	NA	NA
Uranium-238	NA	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.
The RGO was exceeded for these compounds at these locations.

Table E.11. Comparison of EPCs to RGOs for a HI of 1.0 for the Industrial Worker at the NSDD

COC	RGO (HI=1)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	>1E+05 [a]	1.3E+04	8.1E+03	6.4E+03
Antimony	1.3E+03	2.1E-01	1.4E+01	1.0E+01
Arsenic	8.8E+02	1.2E+01	5.8E+00	6.0E+00
Beryllium	5.4E+03	6.7E-01	6.5E-01	5.8E-01
Cadmium	2.7E+03	2.1E-01	ND	2.1E+00
Iron	>1E+05 [a]	2.8E+04	1.1E+04	9.3E+03
Manganese	>1E+05 [a]	1.5E+03	4.2E+02	4.6E+02
Nickel	7.5E+04	2.1E+01	9.4E+01	1.6E+01
Uranium	2.3E+03	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	NA	NA	2.7E+00	1.1E+00
Total PAH (as (BaPE)	NA	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	NA	NA	4.4E+00	4.8E-01
Cesium-137	NA	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	NA	NA	ND	ND
Neptunium-237	NA	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	NA	2.5E-02	2.1E+01	4.8E+00
Technetium-99	NA	2.5E+00	6.0E+02	3.2E+01
Thorium-228	NA	1.6E+00	2.0E+00	4.7E-01
Thorium-230	NA	1.5E+00	5.0E+02	6.7E+01
Thorium-232	NA	1.5E+00	2.4E+00	5.6E-01
Uranium-234	NA	2.5E+00	2.9E+01	3.0E+00
Uranium-235	NA	1.4E-01	NA	NA
Uranium-238	NA	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

Table E.12. Comparison of EPCs to RGOs for a ELCR 1E-6 for the Industrial Worker at the NSDD

COC	RGO (ELCR =1E-6)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	NA	1.3E+04	8.1E+03	6.4E+03
Antimony	NA	2.1E-01	1.4E+01	1.0E+01
Arsenic	5.48E+00	1.2E+01	5.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	6.5E-01	5.8E-01
Cadmium	NA	2.1E-01	ND	2.1E+00
Iron	NA	2.8E+04	1.1E+04	9.3E+03
Manganese	NA	1.5E+03	4.2E+02	4.6E+02
Nickel	NA	2.1E+01	9.4E+01	1.6E+01
Uranium	NA	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	3.19E+00	NA	2.7E+00	1.1E+00
Total PAH (as BaPE)	5.43E-01	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	2.30E+01	NA	4.4E+00	4.8E-01
Cesium-137	1.52E+00	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	3.15E-01	NA	ND	ND
Neptunium-237	4.33E+00	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	2.15E+01	2.5E-02	2.1E+01	4.8E+00
Technetium-99	7.65E+02	2.5E+00	6.0E+02	3.2E+01
Thorium-230	2.93E+01	1.5E+00	5.0E+02	6.7E+01
Thorium-232	2.57E+01	1.5E+00	2.4E+00	5.6E-01
Uranium-234	3.76E+01	2.5E+00	2.9E+01	3.0E+00
Uranium-235	6.05E+00	1.4E-01	NA	NA
Uranium-238	1.88E+01	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

The RGO was exceeded for these compounds at these locations, but was less than the background concentration.

The RGO was exceeded for these compounds at these locations.

Table E.13. Comparison of EPCs to RGOs for a ELCR 1E-5 for the Industrial Worker at the NSDD

COC	RGO (ELCR =1E-5)	Background Soil Conc.	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	NA	1.3E+04	8.1E+03	6.4E+03
Antimony	NA	2.1E-01	1.4E+01	1.0E+01
Arsenic	5.48E+01	1.2E+01	5.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	6.5E-01	5.8E-01
Cadmium	NA	2.1E-01	ND	2.1E+00
Iron	NA	2.8E+04	1.1E+04	9.3E+03
Manganese	NA	1.5E+03	4.2E+02	4.6E+02
Nickel	NA	2.1E+01	9.4E+01	1.6E+01
Uranium	NA	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	3.19E+01	NA	2.7E+00	1.1E+00
Total PAH (as (BaPE)	5.43E+00	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	2.30E+02	NA	4.4E+00	4.8E-01
Cesium-137	1.52E+01	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	3.15E+00	NA	ND	ND
Neptunium-237	4.33E+01	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	2.15E+02	2.5E-02	2.1E+01	4.8E+00
Technetium-99	7.65E+03	2.5E+00	6.0E+02	3.2E+01
Thorium-230	2.93E+02	1.5E+00	5.0E+02	6.7E+01
Thorium-232	2.57E+02	1.5E+00	2.4E+00	5.6E-01
Uranium-234	3.76E+02	2.5E+00	2.9E+01	3.0E+00
Uranium-235	6.05E+01	1.4E-01	NA	NA
Uranium-238	1.88E+02	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.
The RGO was exceeded for these compounds at these locations.

E.1.7 Comparison of RGOs to COCs for the Recreational User at the NSDD

A comparison of the potential RGOs for risk, hazard, and dose identified in Tables E.1 through E.4 to the concentrations of the COCs within the NSDD, Hot Spot and NSDD, Excluding the Hot Spot, as identified in Sections 1.4 and 1.7, was completed to determine any exceedances of the potential RGOs of risk, hazard, or dose for the recreational user at the NSDD. This information is summarized in Tables E.14 and E.18. Tables E.14 and Table E.15 illustrate the COCs that exceed an HI of 0.1 and 1.0, respectively. It should be noted that no COCs were found to exceed an HI of 1.0 or 3.0.

Tables E.16 and E.17 illustrate the COCs that exceed an ELCR of 1E-6 and 1E-5, respectively. Total PCB, Total PAH (as BaPE), cesium-137, neptunium-237, thorium-230 and uranium-238 exhibited an ELCR >1E-6 at either the NSDD, Hot Spot or NSDD, Excluding the Hot Spot. All other COCs (arsenic) with an ELCR >1E-6 were at or below background levels. Total PAH (as BaPE) exhibited an ELCR >1E-5 for the NSDD, Hot Spot and NSDD, Excluding the Hot Spot. As previously noted in Section E.1.4.1, “Other Contaminants of Concern,” PAHs currently are not targeted as part of this action. No COCs were identified at an ELCR >1E-4 for the NSDD, Hot Spot and NSDD, Excluding the Hot Spot.

Table E.18 shows the dose-based risk for the recreational user for the NSDD, Hot Spot and the NSDD, Excluding the Hot Spot for 1 mrem/yr, 15 mrem/yr, and 25 mrem/yr. No COCs had a concentration that exceeded either the 25 mrem/yr-based cleanup level or a lower 15 mrem/yr-based value.

Table E.14. Comparison of EPCs to RGOs for a HI of 0.1 for the Recreational User at the NSDD

COC	RGO (HI =0.1)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	>1E+05 [a]	1.3E+04	8.1E+03	6.4E+03
Antimony	2.7E+01	2.1E-01	1.4E+01	1.0E+01
Arsenic	1.4E+01	1.2E+01	5.8E+00	6.0E+00
Beryllium	6.8E+01	6.7E-01	6.5E-01	5.8E-01
Cadmium	3.4E+01	2.1E-01	ND	2.1E+00
Iron	>1E+05 [a]	2.8E+04	1.1E+04	9.3E+03
Manganese	1.7E+04	1.5E+03	4.2E+02	4.6E+02
Nickel	1.1E+04	2.1E+01	9.4E+01	1.6E+01
Uranium	5.3E+02	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	NA	NA	2.7E+00	1.1E+00
Total PAH (as BaPE)	NA	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	NA	NA	4.4E+00	4.8E-01
Cesium-137	NA	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	NA	NA	ND	ND
Neptunium-237	NA	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	NA	2.5E-02	2.1E+01	4.8E+00
Technetium-99	NA	2.5E+00	6.0E+02	3.2E+01
Thorium-228	NA	1.6E+00	2.0E+00	4.7E-01
Thorium-230	NA	1.5E+00	5.0E+02	6.7E+01
Thorium-232	NA	1.5E+00	2.4E+00	5.6E-01
Uranium-234	NA	2.5E+00	2.9E+01	3.0E+00
Uranium-235	NA	1.4E-01	NA	NA
Uranium-238	NA	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

Table E.15. Comparison of EPCs to RGOs for a HI of 1.0 for the Recreational User at the NSDD

COC	RGO (HI =1.0)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	2.7E+05	1.3E+04	8.1E+03	6.4E+03
Antimony	2.6E+01	2.1E-01	1.4E+01	1.0E+01
Arsenic	1.4E+02	1.2E+01	5.8E+00	6.0E+00
Beryllium	6.8E+01	6.7E-01	6.5E-01	5.8E-01
Cadmium	3.4E+02	2.1E-01	ND	2.1E+00
Iron	>1E+05 [a]	2.8E+04	1.1E+04	9.3E+03
Manganese	>1E+05 [a]	1.5E+03	4.2E+02	4.6E+02
Nickel	>1E+05 [a]	2.1E+01	9.4E+01	1.6E+01
Uranium	5.3E+03	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	NA	NA	2.7E+00	1.1E+00
Total PAH (as BaPE)	NA	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	NA	NA	4.4E+00	4.8E-01
Cesium-137	NA	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	NA	NA	ND	ND
Neptunium-237	NA	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	NA	2.5E-02	2.1E+01	4.8E+00
Technetium-99	NA	2.5E+00	6.0E+02	3.2E+01
Thorium-228	NA	1.6E+00	2.0E+00	4.7E-01
Thorium-230	NA	1.5E+00	5.0E+02	6.7E+01
Thorium-232	NA	1.5E+00	2.4E+00	5.6E-01
Uranium-234	NA	2.5E+00	2.9E+01	3.0E+00
Uranium-235	NA	1.4E-01	NA	NA
Uranium-238	NA	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

Table E.16. Comparison of EPCs to RGOs for a ELCR 1E-6 for the Recreational User at the NSDD

COC	RGO (ELCR =1E-6)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	NA	1.3E+04	8.1E+03	6.4E+03
Antimony	NA	2.1E-01	1.4E+01	1.0E+01
Arsenic	1.8E+00	1.2E+01	5.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	6.5E-01	5.8E-01
Cadmium	NA	2.1E-01	ND	2.1E+00
Iron	NA	2.8E+04	1.1E+04	9.3E+03
Manganese	NA	1.5E+03	4.2E+02	4.6E+02
Nickel	NA	2.1E+01	9.4E+01	1.6E+01
Uranium	NA	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	6.44E-01	NA	2.7E+00	1.1E+00
Total PAH (as BaPE)	6.69E-02	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	8.11E+01	NA	4.4E+00	4.8E-01
Cesium-137	1.19E+00	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	2.45E-01	NA	ND	ND
Neptunium-237	3.78E+00	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	2.37E+02	2.5E-02	2.1E+01	4.8E+00
Technetium-99	7.06E+03	2.5E+00	6.0E+02	3.2E+01
Thorium-230	3.02E+02	1.5E+00	5.0E+02	6.7E+01
Thorium-232	2.79E+02	1.5E+00	2.4E+00	5.6E-01
Uranium-234	4.07E+02	2.5E+00	2.9E+01	3.0E+00
Uranium-235	5.53E+00	1.4E-01	NA	NA
Uranium-238	2.46E+01	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.

The RGO was exceeded for these compounds at these locations, but was less than the background concentration.

The RGO was exceeded for these compounds at these locations.

Table E.17. Comparison of EPCs to RGOs for a ELCR 1E-5 for the Recreational User at the NSDD

COC	RGO (ELCR =1E-5)	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Inorganic Chemicals (Metals) (mg/kg in Soil/Sediment)				
Aluminum	NA	1.3E+04	8.1E+03	6.4E+03
Antimony	NA	2.1E-01	1.4E+01	1.0E+01
Arsenic	1.81E+01	1.2E+01	5.8E+00	6.0E+00
Beryllium	>1E+05 [a]	6.7E-01	6.5E-01	5.8E-01
Cadmium	NA	2.1E-01	ND	2.1E+00
Iron	NA	2.8E+04	1.1E+04	9.3E+03
Manganese	NA	1.5E+03	4.2E+02	4.6E+02
Nickel	NA	2.1E+01	9.4E+01	1.6E+01
Uranium	NA	4.9E+00	3.3E+02	1.6E+02
Organic Compounds (mg/kg in Soil/Sediment)				
Total PCB	6.44E+00	NA	2.7E+00	1.1E+00
Total PAH (as BaPE)	6.69E-01	NA	1.0E+00	1.2E+00
Radionuclides (pCi/g in Soil/Sediment)				
Americium-241	8.11E+02	NA	4.4E+00	4.8E-01
Cesium-137	1.19E+01	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	2.45E+00	NA	ND	ND
Neptunium-237	3.78E+01	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	2.37E+03	2.5E-02	2.1E+01	4.8E+00
Technetium-99	7.06E+04	2.5E+00	6.0E+02	3.2E+01
Thorium-230	3.02E+03	1.5E+00	5.0E+02	6.7E+01
Thorium-232	2.79E+03	1.5E+00	2.4E+00	5.6E-01
Uranium-234	4.07E+03	2.5E+00	2.9E+01	3.0E+00
Uranium-235	5.53E+01	1.4E-01	NA	NA
Uranium-238	2.46E+02	1.2E+00	2.6E+01	4.3E+00

[a] Screening values greater than 100,000 mg/kg are reported as >1E+5, as required in Appendix A of the Risk Methods Document.
The RGO was exceeded for these compounds at these locations.

Table E.18. Comparison of EPCs to Dose-Based RGOs for the Recreational User for the NSDD

COC	1mrem/yr	15 mrem/yr	25 mrem/yr	Background Soil Concentration	NSDD Hot Spot	NSDD, Excluding Hot Spot
Radionuclides (pCi/g in Soil/Sediment)						
Americium-241	4.34E+01	6.51E+02	1.08E+03	NA	4.4E+00	4.8E-01
Cesium-137	1.07E+01	1.60E+02	2.67E+02	4.9E-01	4.2E+00	7.6E-01
Cobalt-60	2.25E+00	3.38E+01	5.63E+01	NA	ND	ND
Neptunium-237+D	1.76E+01	2.64E+02	4.40E+02	1.0E-01	5.3E+00	2.8E-01
Plutonium-239/240	4.70E+01	7.06E+02	1.18E+03	2.5E-02	2.1E+01	4.8E+00
Technetium-99	8.19E+04	1.23E+06	2.05E+06	2.5E+00	6.0E+02	3.2E+01
Thorium-230	3.00E+02	4.51E+03	7.51E+03	1.5E+00	5.0E+02	6.7E+01
Thorium-232	6.09E+01	9.13E+02	1.52E+03	1.5E+00	2.4E+00	5.6E-01
Uranium-234	5.84E+02	8.76E+03	1.46E+04	2.5E+00	2.9E+01	3.0E+00
Uranium-235+D	4.48E+01	6.71E+02	1.12E+03	1.4E-01	NA	NA
Uranium-238+D	1.89E+02	2.84E+03	4.73E+03	1.2E+00	2.6E+01	4.3E+00

Table E.19. Slope Factors Employed in Risk Calculation

Chemical	Ingestion Slope Factor[a] (mg/kg-day)$^{-1}$	Dermal Slope Factor[a] (mg/kg-day)$^{-1}$	Inhalation Slope Factor[a] (mg/kg-day)$^{-1}$	External Exposure Slope Factor[a] (mg/kg-day)$^{-1}$
Arsenic	1.50E+00	3.66E+00	1.51E+01	NA
Beryllium	NA	NA	8.40E+00	NA
Cadmium	NA	NA	6.30E+00	NA
Total PCB	2.00E+00	2.22E+00	2.00E+00	NA
Total PAH (as BePE)	7.30E+00	2.35E+01	3.08E+00	NA
Chemical	**Ingestion Slope Factor[b] (risk/pCi)**		**Inhalation Slope Factor[b] (risk/pCi)**	**External Exposure Slope Factor[b] (risk/yr per pCi/g)**
Americium-241	2.17E-10	NA	2.81E-08	2.76E-08
Cesium-137+D	4.33E-11	NA	1.19E-11	2.55E-06
Cobalt-60	4.03E-11	NA	3.58E-11	1.24E-05
Neptunium-237+D	1.62E-10	NA	1.77E-08	7.97E-07
Plutonium-239/240	2.76E-10	NA	3.33E-08	2.00E-10
Technetium-99	7.66E-12	NA	1.41E-11	8.14E-11
Thorium-230	2.02E-10	NA	2.85E-08	8.19E-10
Thorium-232	2.31E-10	NA	4.33E-08	3.42E-10
Uranium-234	1.58E-10	NA	1.14E-08	2.52E-10
Uranium-235+D	1.57E-10	NA	1.01E-08	5.43E-07
Uranium-238	1.43E-10	NA	9.32E-09	4.99E-11

[a]All values from RAIS
[b]All values from HEAST

Table E.20. Reference Doses Employed in Hazard Calculation

Chemical	Oral RfD[a] (mg/kg-day)	Dermal RfD[a] (mg/kg-day)	Inhalation Rfd[a] (mg/kg-day)	Dermal Absorption Factor[a]
Aluminum	1.00E+00	1.00E-01	1.43E-03	1.00E-03
Antimony	4.00E-04	8.00E-06	NA	1.00E-03
Arsenic	3.00E-04	1.23E-04	NA	3.00E-02
Beryllium	2.00E-03	2.00E-05	5.71E-06	1.00E-03
Cadmium	1.00E-03	1.00E-05	NA	1.00E-03
Iron	3.00E-01	4.50E-02	NA	1.00E-03
Lead	NA	NA	NA	1.00E-03
Manganese	1.40E-01	5.60E-03	1.43E-05	1.00E-03
Nickel	2.00E-02	5.40E-03	NA	1.00E-03
Uranium	6.00E-04	5.10E-04	NA	1.00E-03
Fluoranthene	4.00E-02	1.24E-02	NA	1.30E-01
Pyrene	3.00E-02	9.30E-03	NA	1.00E-01

[a]All values from RAIS

ATTACHMENT E1

RISK EVALUATION CLEANUP MAPS

THIS PAGE INTENTIONALLY LEFT BLANK

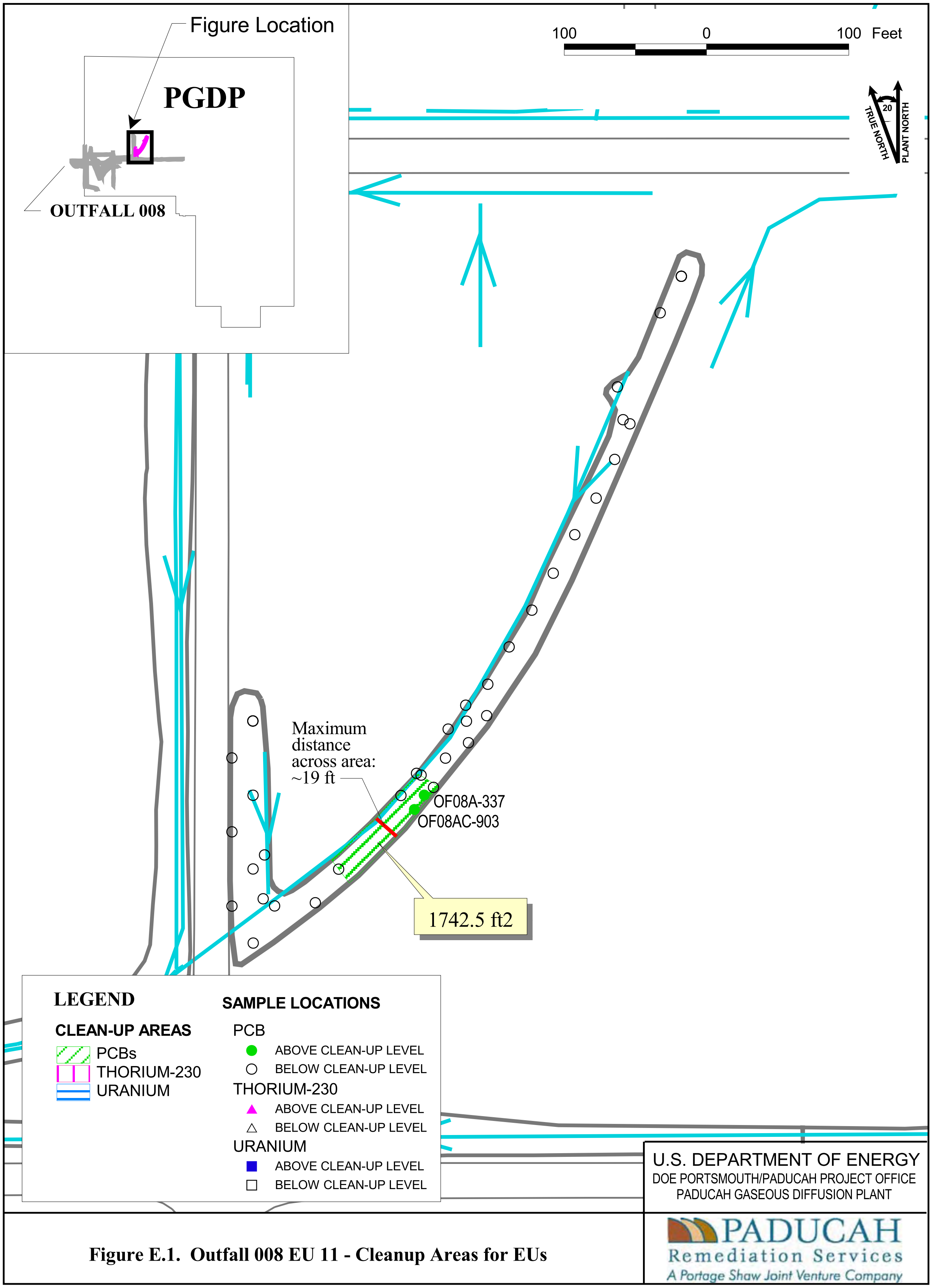


Figure E.1. Outfall 008 EU 11 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07

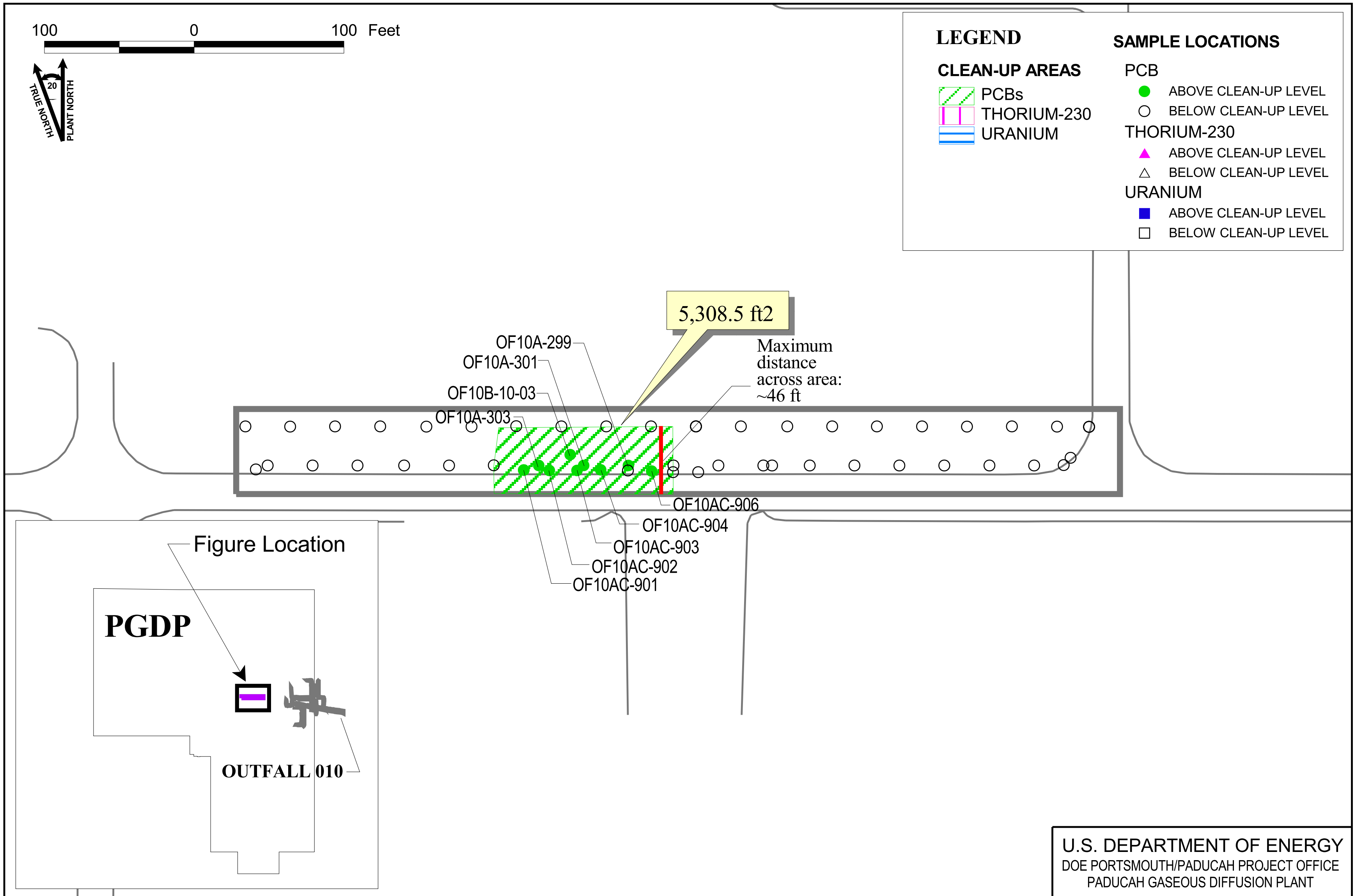
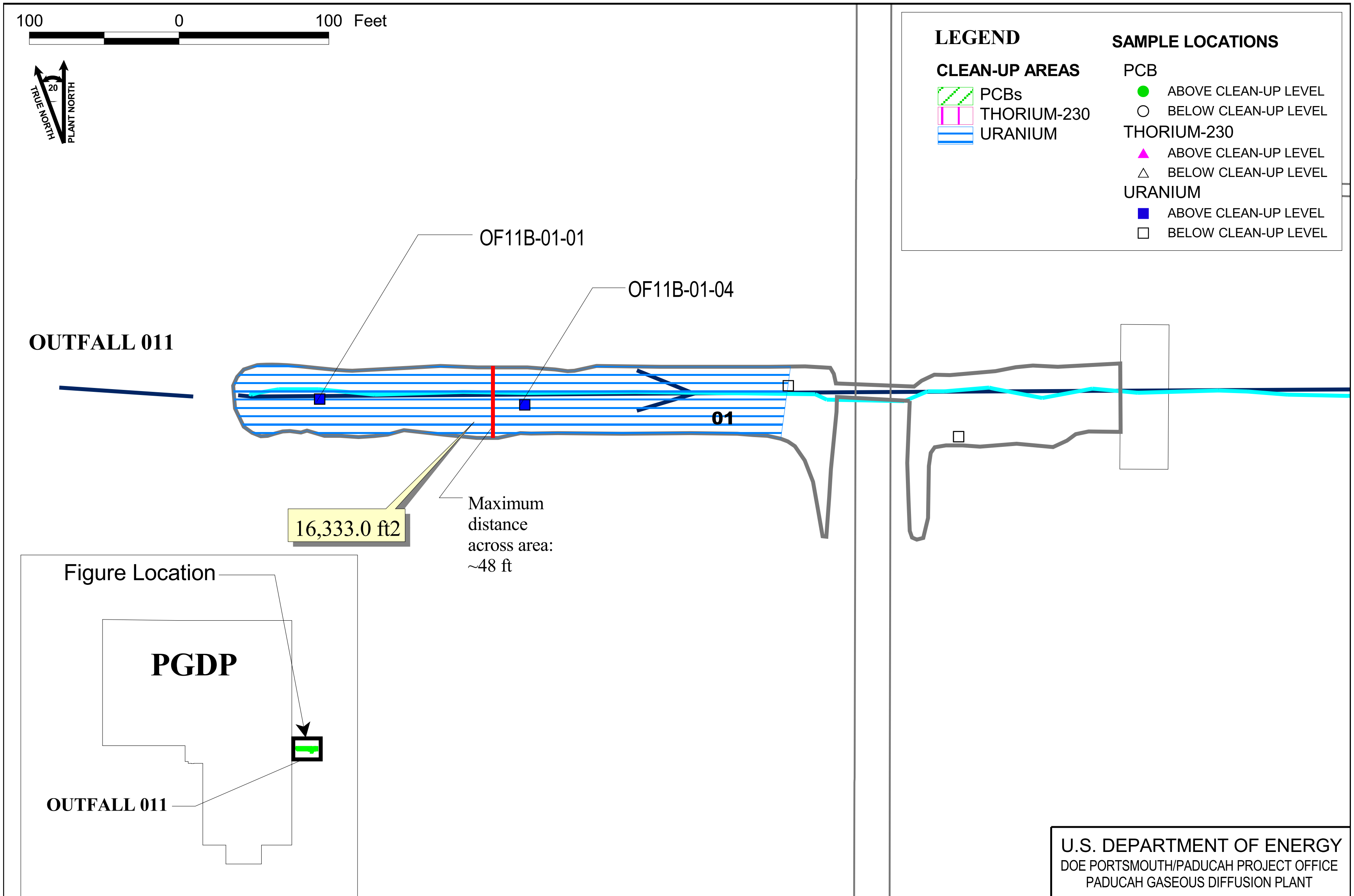


Figure E.2. Outfall 010 EU 10 - Cleanup Areas for EUs

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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07



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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure E.3. Outfall 011 EU 01 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07

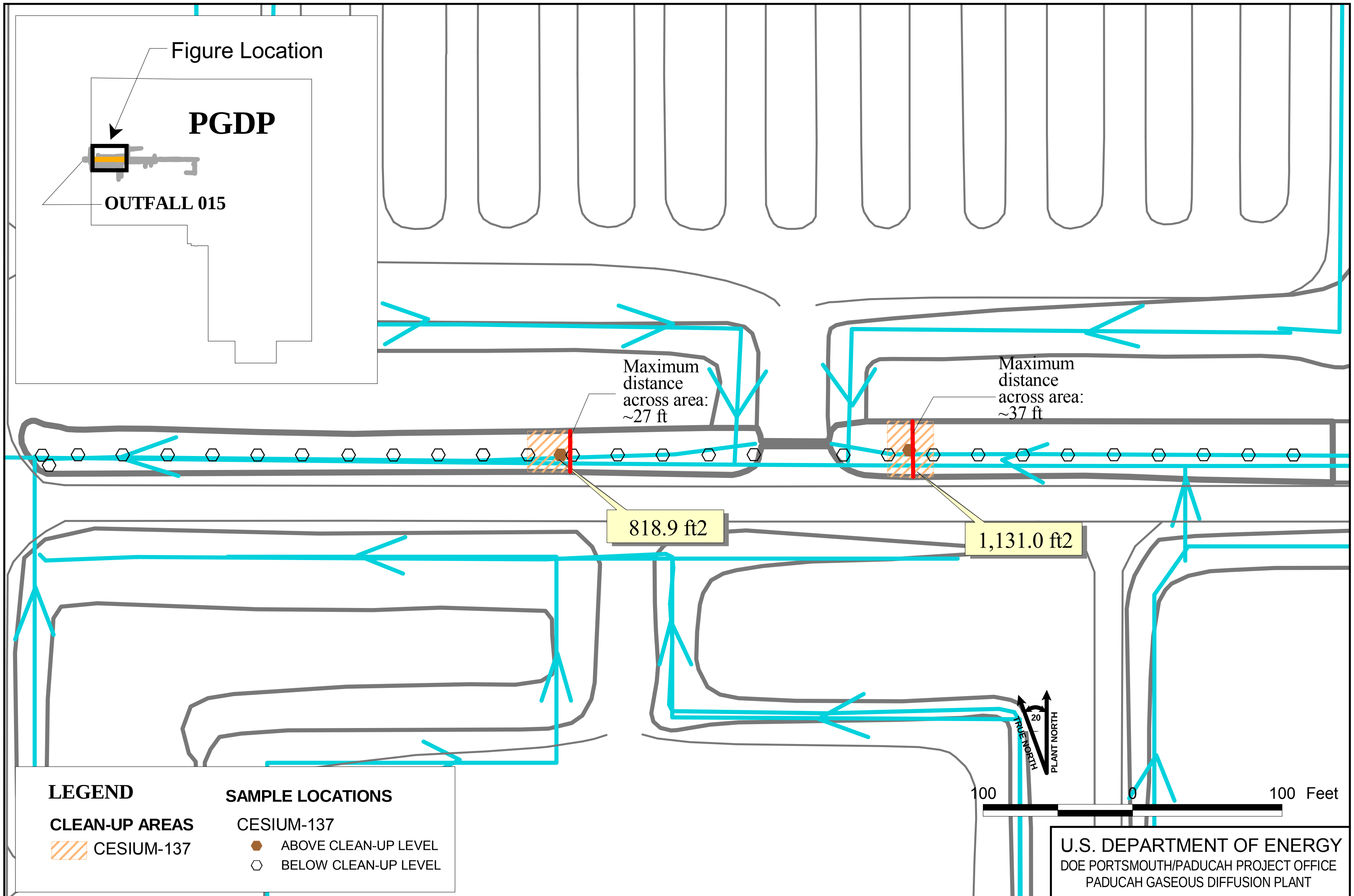
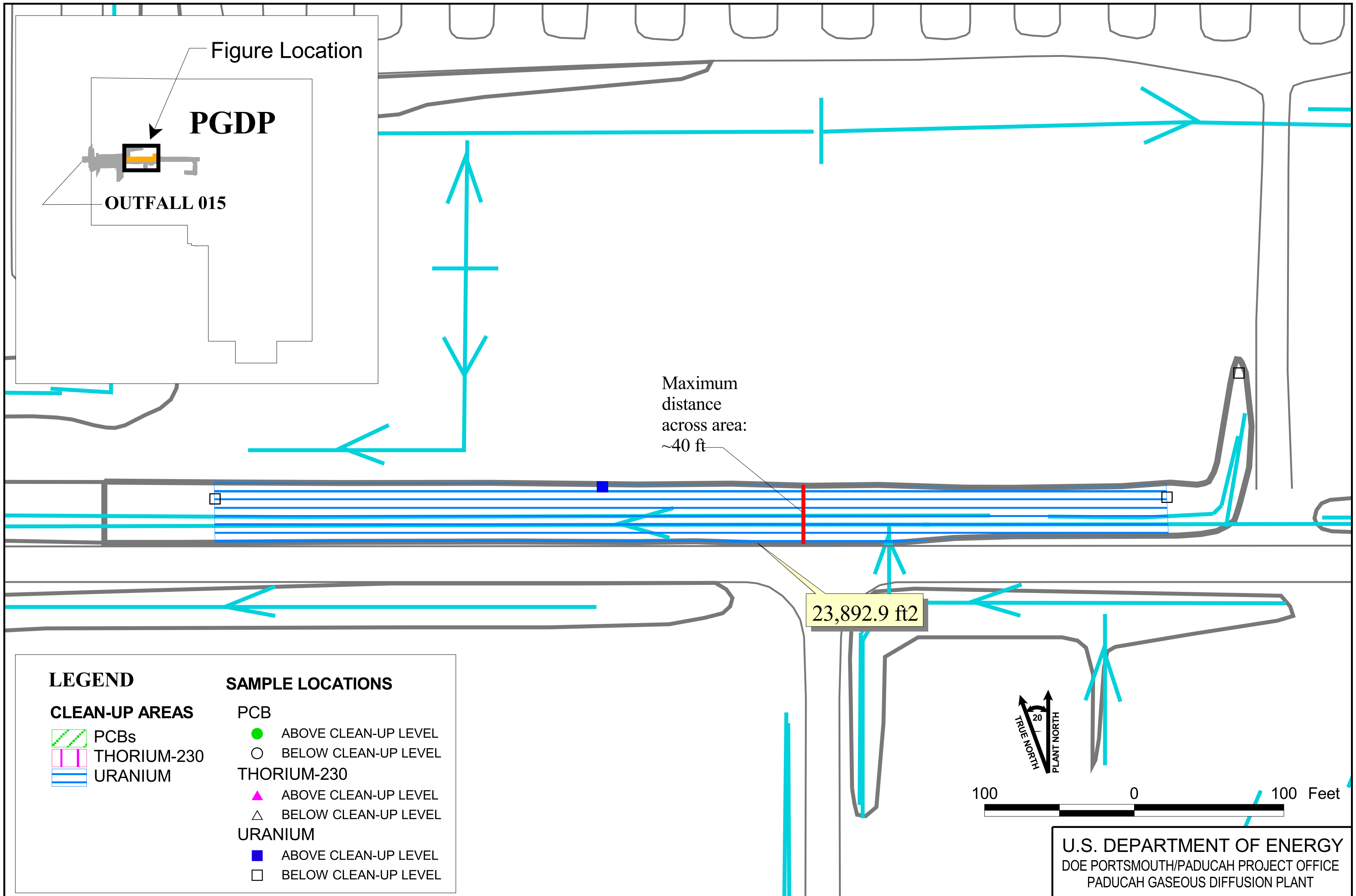


Figure E.4. Outfall 015 EU 02 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 09-10-07



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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure E.5. Outfall 015 EU 03 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07

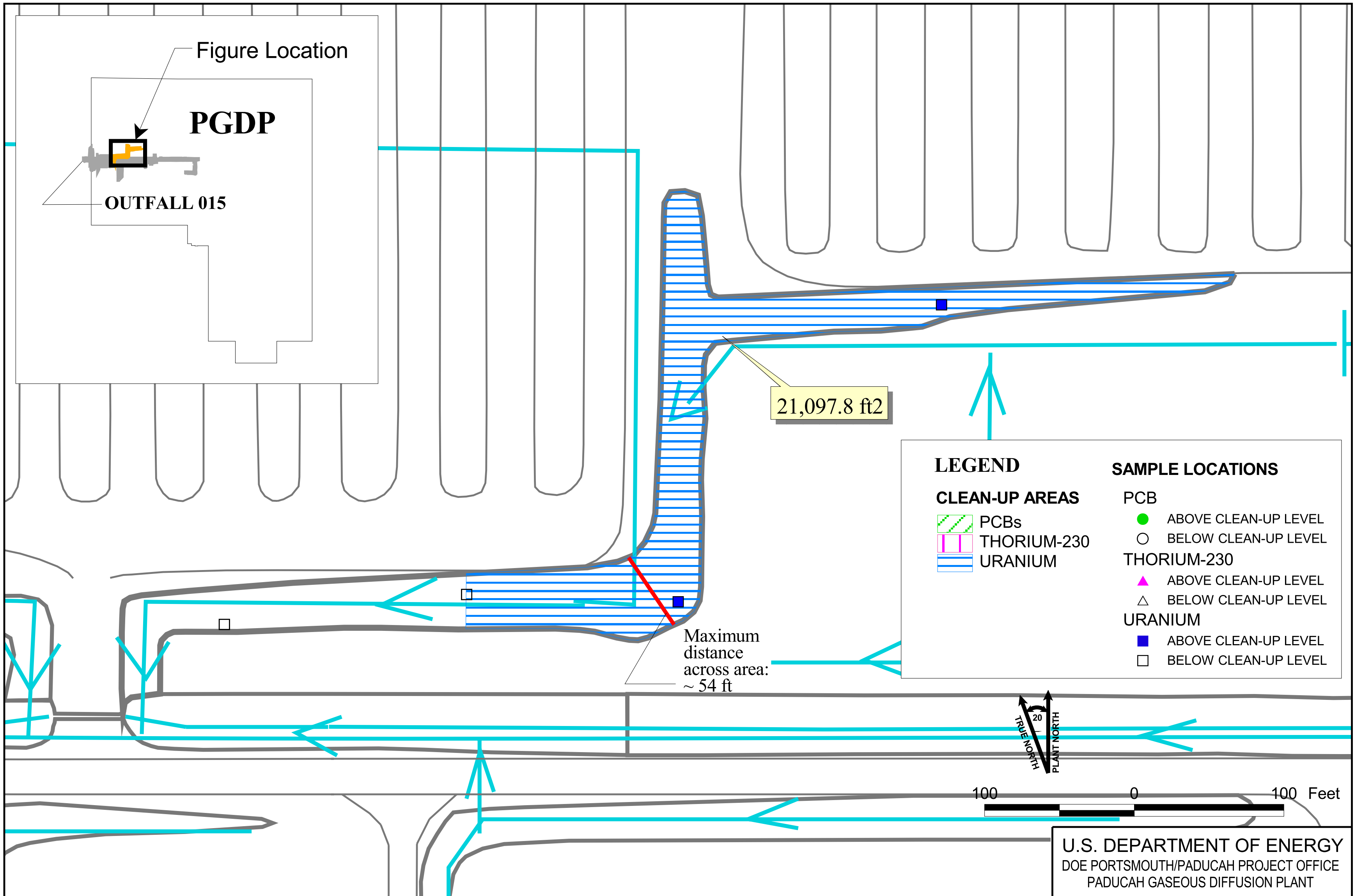


Figure E.6. Outfall 015 EU 07 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07

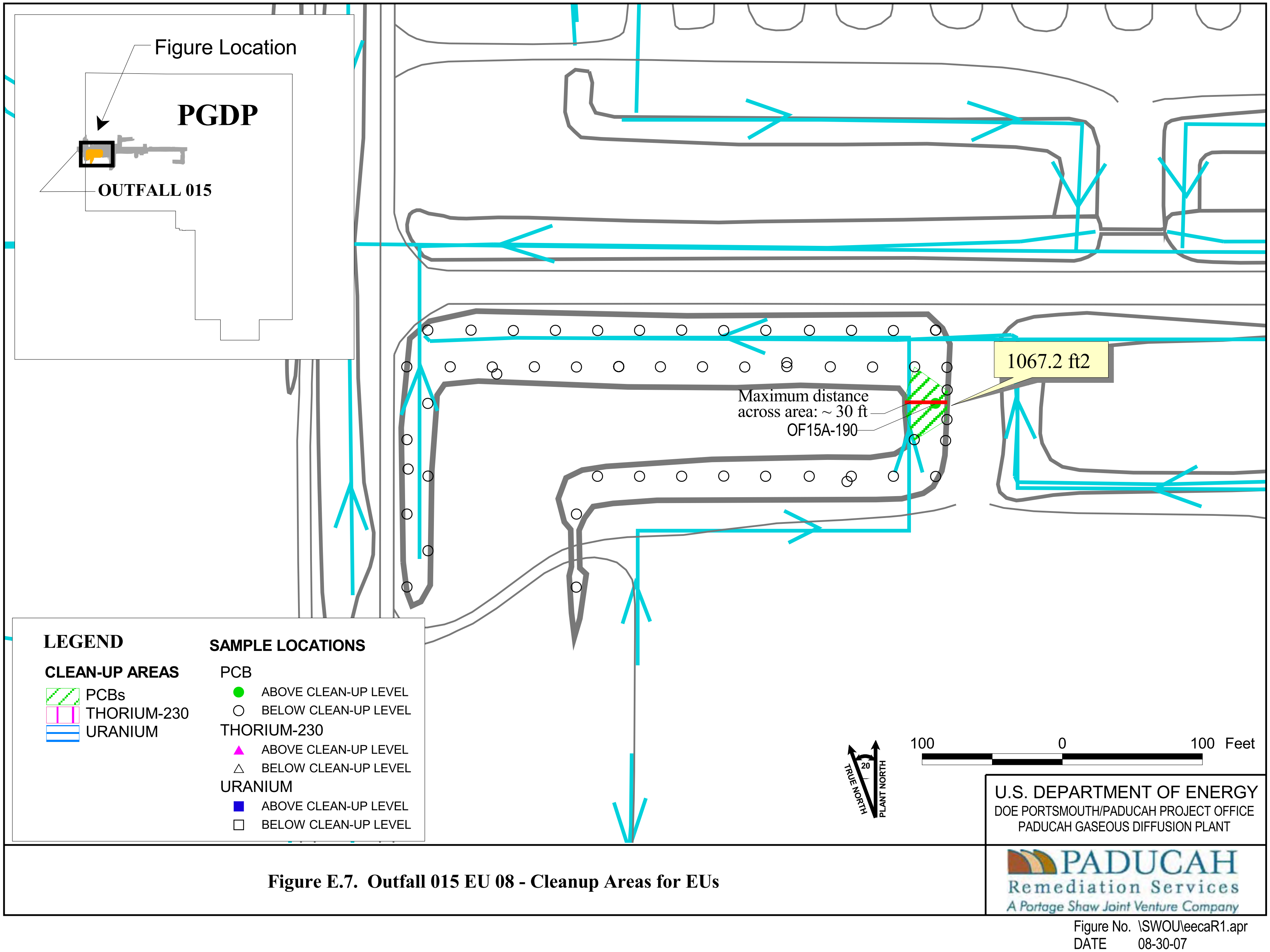


Figure E.7. Outfall 015 EU 08 - Cleanup Areas for EUs

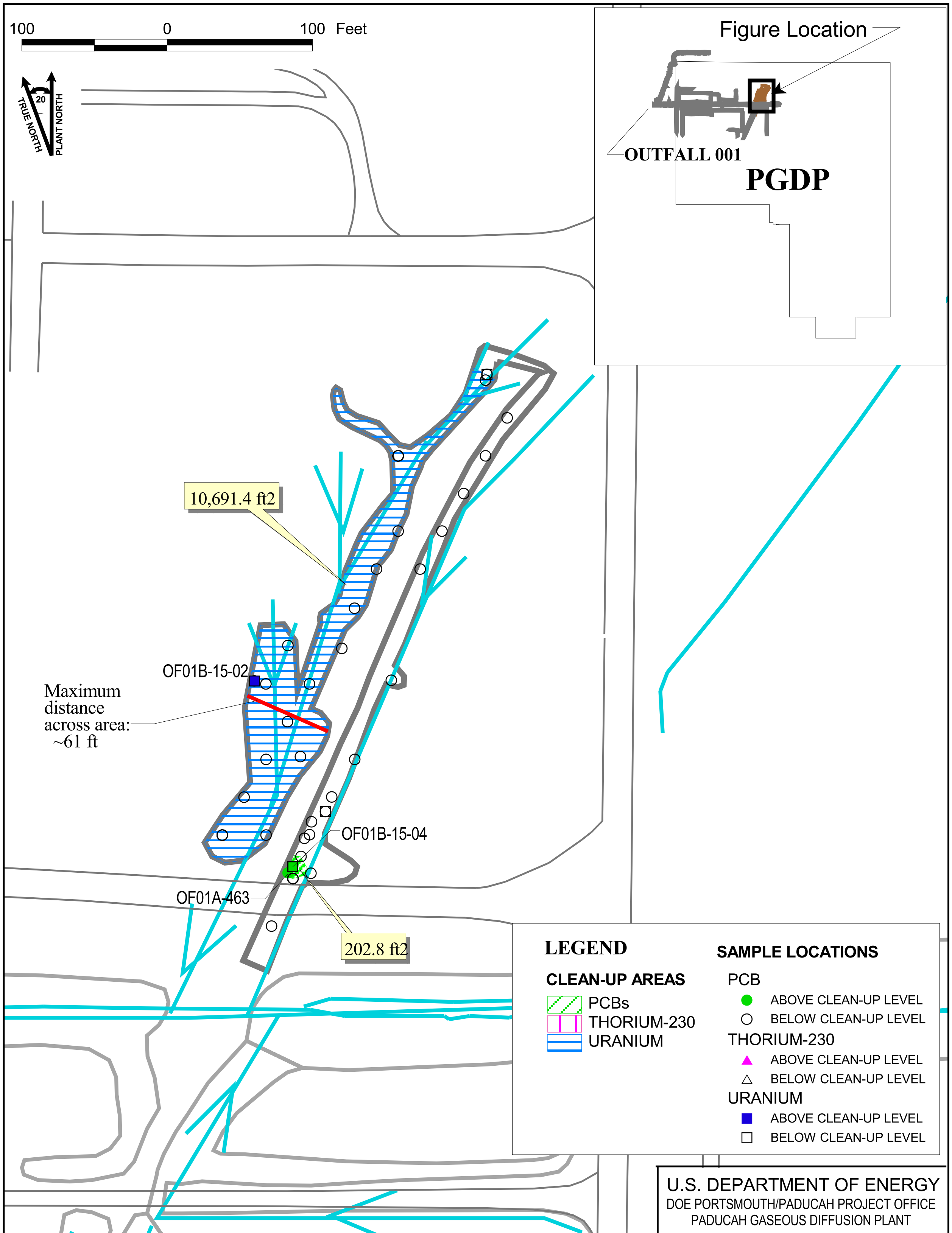
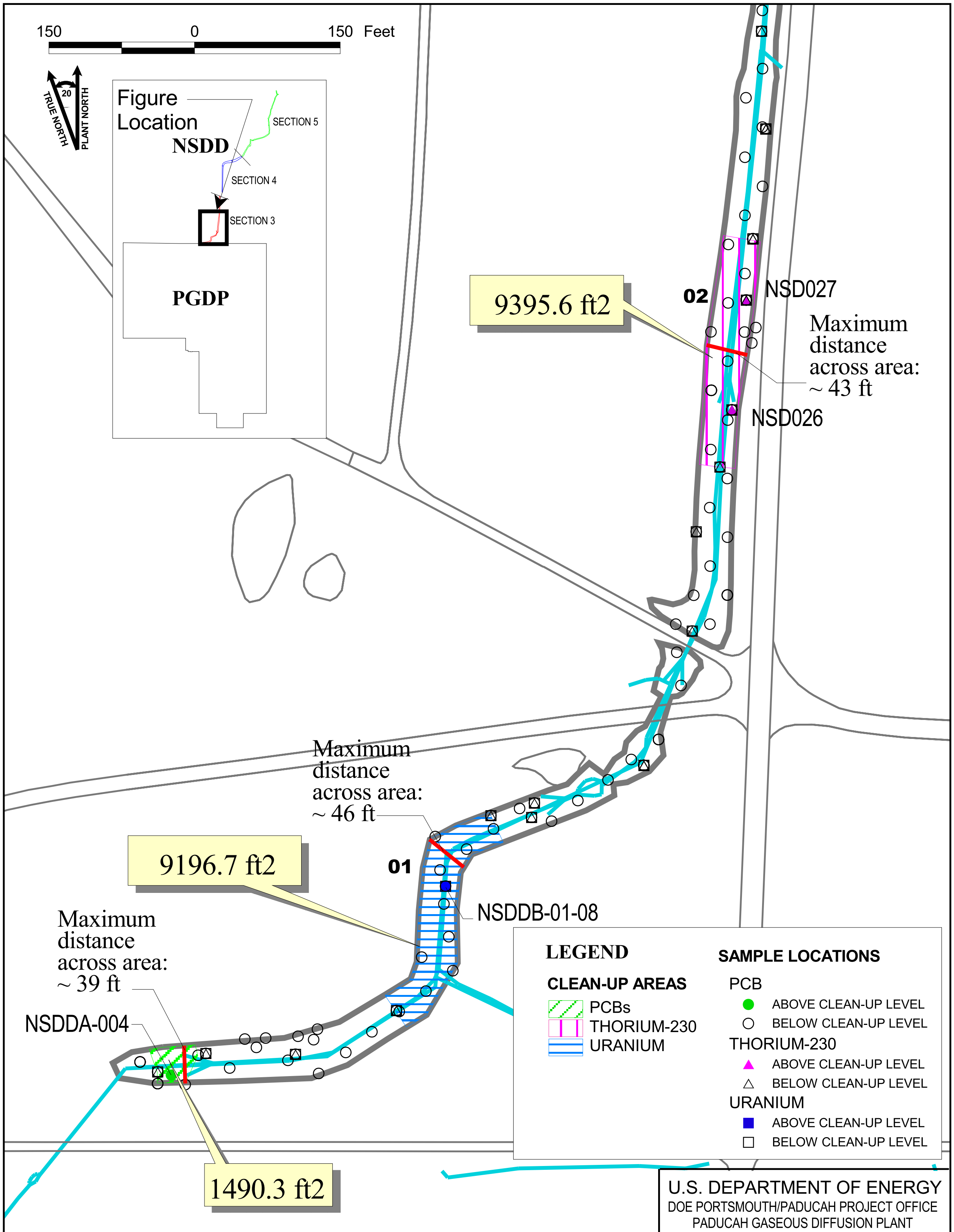


Figure E.8. Outfall 001 EU 15 - Cleanup Areas for EUs

Figure No. \SWOU\eecaR1.apr
DATE 08-30-07

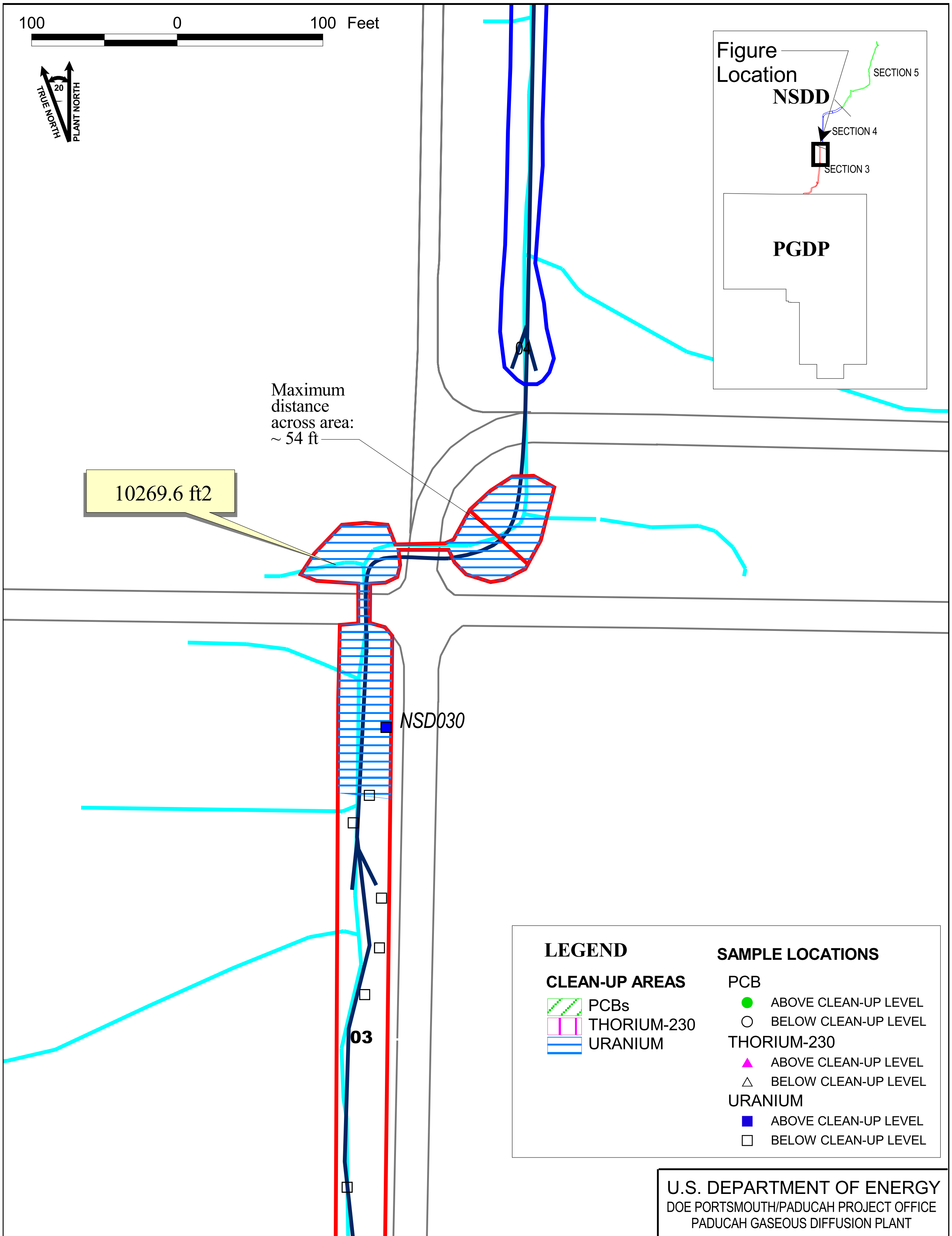


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure E.9. NSDD Section 3 EUs 01 and 02 - Cleanup Areas for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eecar1.apr
DATE 08-30-07



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

Figure E.10. NSDD Section 3 EU 03 - Cleanup Area for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eecar1.apr
DATE 08-30-07

APPENDIX F

RISK-BASED COST-BENEFIT ANALYSIS

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix F presents the risk-based cost-benefit analysis used to select the cumulative excess lifetime cancer risk (ELCR) and hazard cleanup level targets for the Surface Water Operable Unit (SWOU) (On-Site) Engineering Evaluation/Cost Analysis (EE/CA). The appendix details how different risk targets are related to the size of the area that might be excavated under the recommended alternative and the cost of excavation. In addition, the appendix presents an example of the residual risk that might exist after implementing the alternative. This example utilizes EU10 of Outfall 10, which has the greatest polychlorinated biphenyl (PCB) concentrations found during the SWOU (On-Site) Site Investigation (SI). The evaluation concludes with a listing of the concentrations of the contaminants of concern (COCs) that are proposed for use as verification levels (i.e., target cleanup levels) during implementation of the recommended alternative.[12]

As discussed earlier in the report (see Section E.1.4.1), total polycyclic aromatic hydrocarbon compounds [Total polyaromatic hydrocarbons (PAHs)] were not selected as a COC to direct cleanup under the recommended alternative; therefore, Total PAHs were not considered in this risk-based cost-benefit analysis.

F.1.1 RISK-BASED VALUES

The evaluation considered ELCR targets ranging from 1 E-4 to 1E-7. The COCs included in the analysis were those identified in Appendix E for the industrial worker under current site conditions. Risk-based concentrations for each of the COCs used in the analysis are presented Table F.1. The derivation of these values is discussed in Section E.1.

Table F.1. Risk-Based Concentrations for the Industrial Worker Under Current Site Conditions

COC	Risk-Based Concentration
	mg/kg
Arsenic	54.8
Beryllium	100,000
Total PCB	31.9
	pCi/g
Americium-241	230
Cesium-137	15.2
Cobalt-60	3.15
Neptunium-237	43.3
Plutonium-239/240	215
Technetium-99	7,650
Thorium-230	293
Thorium-232	257
Uranium-234	376
Uranium-235	60.5
Uranium-238	188

The risk-based concentrations for the industrial worker under current site conditions were derived using a chemical-specific ELCR of 1E-05 and the following exposure parameters: exposure frequency =14 d/yr; exposure duration=25 yr; ingestion rate=480 mg/d; absorption factor=0.001, except where chemical specific information was available; and surface area=0.193m^2.
Default parameters from the Risk Methods Document were used for all other exposure parameters.
COC = contaminant of concern
PCB = polychlorinated biphenyl compound

[12] Final chemical-specific cleanup level concentrations used for verification samples will be presented in the Removal Action Work Plan.

As shown in Appendix E, risk-based concentrations for the recreational user under current site conditions at an ELCR target of 1E-05 are greater than those of the industrial worker under current site conditions. (That is, the risk-based concentrations calculated for the current industrial worker are "protective" of the current recreational user). The analysis used the risk-based concentrations for the industrial worker for both the outfalls and their associated ditches and Section 3, 4, and 5 of the North-South Diversion Ditch (NSDD).

F.1.2 DATA CALCULATIONS

In the evaluation, the cumulative ELCR was calculated for each location sampled under Activity 1 during the SWOU SI. Because analytical results for Activity 1 samples are limited to Total PCBs, ELCR posed by other COCs was derived using analytical results from the closest Activity 2 sampling location within the exposure unit. [As discussed in the SWOU Sampling and Analysis Plan (DOE 2005), analytical data for some Activity 2 sampling locations were from historical samples. These historical data also were used in the risk-based cost-benefit analysis.]

The evaluation began by calculating the cumulative ELCR for each of the Activity 2 sampling locations using the detected analytical result for all COCs at the location, except that for Total PCBs and the COCs risk- based concentrations listed in Table F.1. Total PCBs analytical results were excluded from the derivation of the cumulative ELCR at Activity 2 sampling locations because the ELCR from Total PCBs was calculated using Activity 1 sampling results. Calculations were completed using the following equation.

$$\frac{\text{COC's Analytical Result}}{\text{COC's Risk-Based Concentration}} \times \text{Target ELCR (1E-05)}.$$

The cumulative ELCR for each Activity 1 location then was derived by adding the cumulative ELCR from the closest Activity 2 sampling location within the exposure unit, with the ELCR from Total PCBs at the Activity 1 location.

Because Total PCBs is not included in the dataset for the historical locations 004-002 and 004-005, a Total PCB result was calculated from the individual PCB results reported. Additionally, the dataset presented in the SWOU SI was found to identify incorrectly the results listed in Table F.2 as detections. These results were corrected as part of the evaluation.

Table F.2. Results Considered Nondetect for Risk-Based Cost-Benefit Analysis

STA_NAME	CHEMICAL_NAME	RESULTS	UNITS	RSLTQUAL
004-002	Americium-241	9.7	pCi/g	A
004-002	Americium-241	0.0967	pCi/g	AX
004-002	Cesium-137	2.3	pCi/g	A
004-002	Cobalt-60	1	pCi/g	A
004-002	Plutonium-239/240	0.0236	pCi/g	A
004-002	Protactinium-234m	490	pCi/g	A
004-002	Technetium-99	2.83	pCi/g	A
004-002	Uranium-235	7	pCi/g	A
004-005	Americium-241	13	pCi/g	A
004-005	Cobalt-60	1	pCi/g	A
004-005	Neptunium-237	0.0808	pCi/g	A
004-005	Protactinium-234m	480	pCi/g	A
004-005	Thorium-234	31	pCi/g	A
004-005	Uranium-235	13	pCi/g	A

F.1.3 AREA CALCULATIONS

The area represented by each location was calculated using a graphic information system (GIS) interface. Subsequently, the cumulative ELCR for each Activity 1 sampling location was compared to ELCR targets ranging from 1E-04 to 1E-07. If the cumulative ELCR for the Activity 1 sampling location exceeded a particular ELCR value within this range, the area represented by the location was added to the total "hot spot" area (i.e., the area targeted for excavation under the recommended alternative) determined using that ELCR target. The results of the area calculations are shown in Table F.3.

Table F.3. Acreage Requiring Cleanup for Range of ELCR Targets

	ELCR Target						
Location	1E-4 Cleanup area (acres)	5E-5 Cleanup area (acres)	1E-5 Cleanup area (acres)	5E-6 Cleanup area (acres)	1E-6 Cleanup area (acres)	5E-7 Cleanup area (acres)	1E-7 Cleanup area (acres)
NSDD	0.00	0.00	0.76	1.29	3.23	4.24	5.36
OUTFALLS	0.20	0.23	1.20	2.11	15.96	26.11	35.95

ELCR = excess lifetime cancer risk.
NSDD = Sections 3, 4, and 5 of the North-South Diversion Ditch.
OUTFALLS = Outfalls and their associated ditches.

The acreage estimated from the calculations was charted. These charts are presented in Figures F.1 (outfalls and associated ditches) and F.2 (NSDD). The vertical lines drawn on each figure indicate break points in the cost-benefit curve. Based upon the figures, the break points are at 1E-5 and 5E-6.

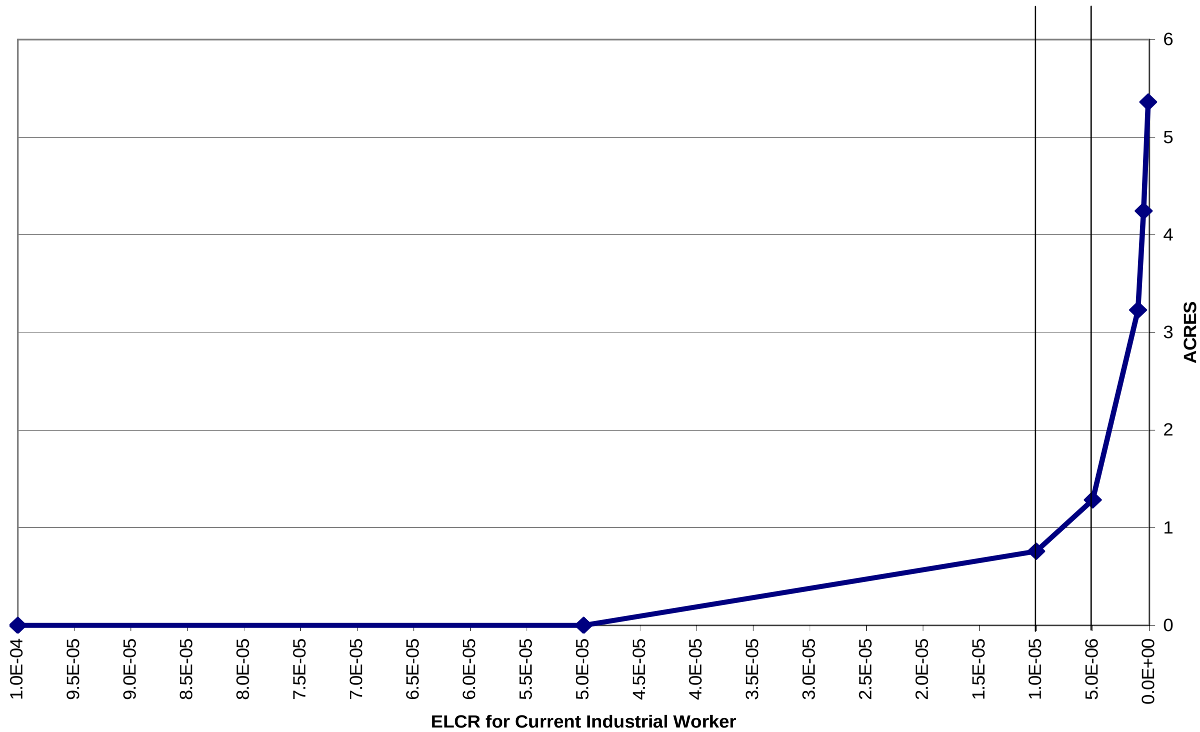


Figure F.1. Acreage Chart for Section 3, 4, and 5 of the NSDD

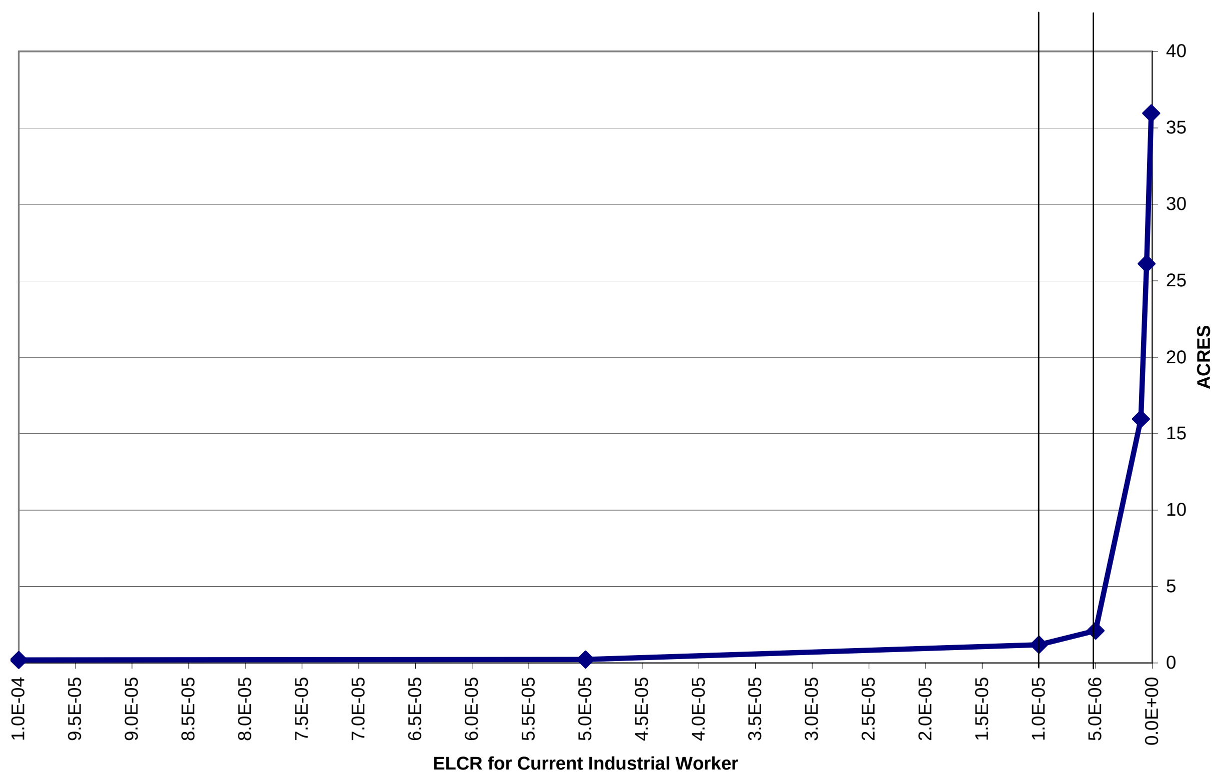


Figure F.2. Acreage Chart for Outfalls and Their Associated Ditches and Areas

F.1.4 COST

Cost of excavating the "hot spots" identified using comparisons to ELCR targets were calculated using a unit cost. These costs are shown in Table F.4. Additionally, Figure F.3 illustrates these costs in comparison to the range of ELCR targets and identifies the break points at 1E-05 and 5E-06.

Table F.4. Estimated Costs for Cleanup

	Cumulative 1E-4 Estimate	Cumulative 1E-5 Estimate	Cumulative 5E-6 Estimate
NSDD	$ 1.7 M	$ 2.2 M	$ 2.9 M
Outfalls	$ 4.0 M	$ 5.0 M	$ 7.0 M
Total	$ 5.7 M	$ 7.2 M	$ 9.9 M

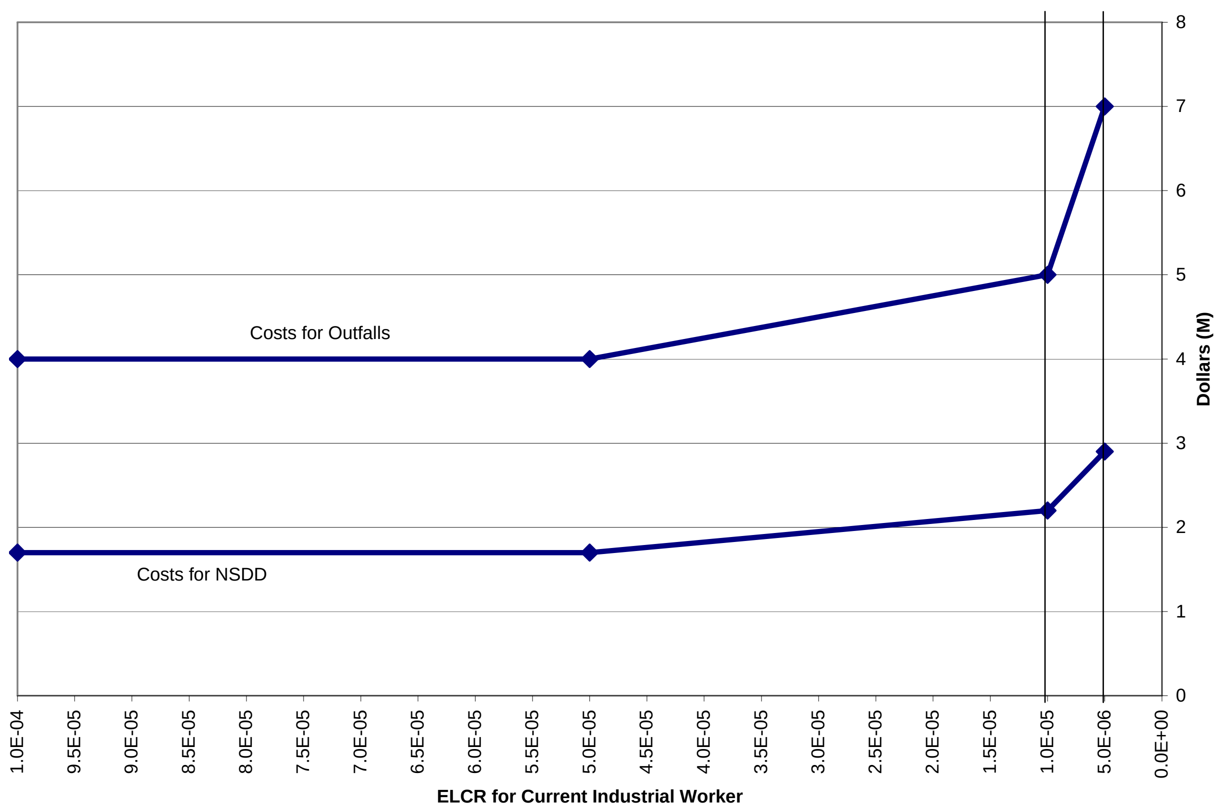


Figure F.3. Cost-Benefit Chart for Outfalls and Associated Internal Ditches and Sections 3, 4, and 5 of the NSDD

F.1.5 Risk to the Future Industrial Worker

To approximate the cumulative ELCR for the future industrial worker (i.e., ELCR to the industrial worker under default rates of exposure, including an exposure frequency of 250 days per year), the cumulative ELCR shown for the industrial worker under current conditions in the figures and tables can be multiplied by 18. This value is the result of dividing the exposure frequency for the future worker (250 days per year) by that for the industrial worker under current conditions (14 days per year). Thus, the cumulative ELCRs of 1E-05 and 5E-06 for the industrial worker under current conditions approximately equate to cumulative ELCRs of 2E-4 and 9E-5, respectively, for the future industrial worker. This is an approximation only, because the exposure scenario for the industrial worker under current conditions assumes an incidental ingestion rate of soil of 480 mg/day, which is approximately 10 times greater than the default incidental ingestion rate of soil used for the future industrial worker (i.e., 50 mg/day).

F.1.6 Risk Reduction

Figure F.4 shows an example of risk reduction that can be achieved by the recommended alternative using an ELCR target of 1E-05. In this example, which uses sampling results from EU10 of Outfall 10, the sampling locations with a cumulative ELCR equal to or greater than 1E-05 are highlighted. The risk in the highlighted area (i.e., the "hot spot") is driven by Total PCBs. The average Total PCB concentration in the "hot spot" is 171 mg/kg and the average Total PCB concentration over the entire EU, including the "hot spot", is 45 mg/kg. After excavation, assuming a Total PCB concentration of zero for the excavated area that would be restored with clean soil, the average Total PCB concentration over the EU is 2 mg/kg.

Effects of cleanup of other "hot spots" identified using a cumulative ELCR target of 1E-05 are shown in Table F.5. In this table, the cumulative ELCR after excavation shown is assumed to be 0 because clean soil with analyte concentrations at or below the site-specific background concentrations is assumed to be used to fill the excavation.

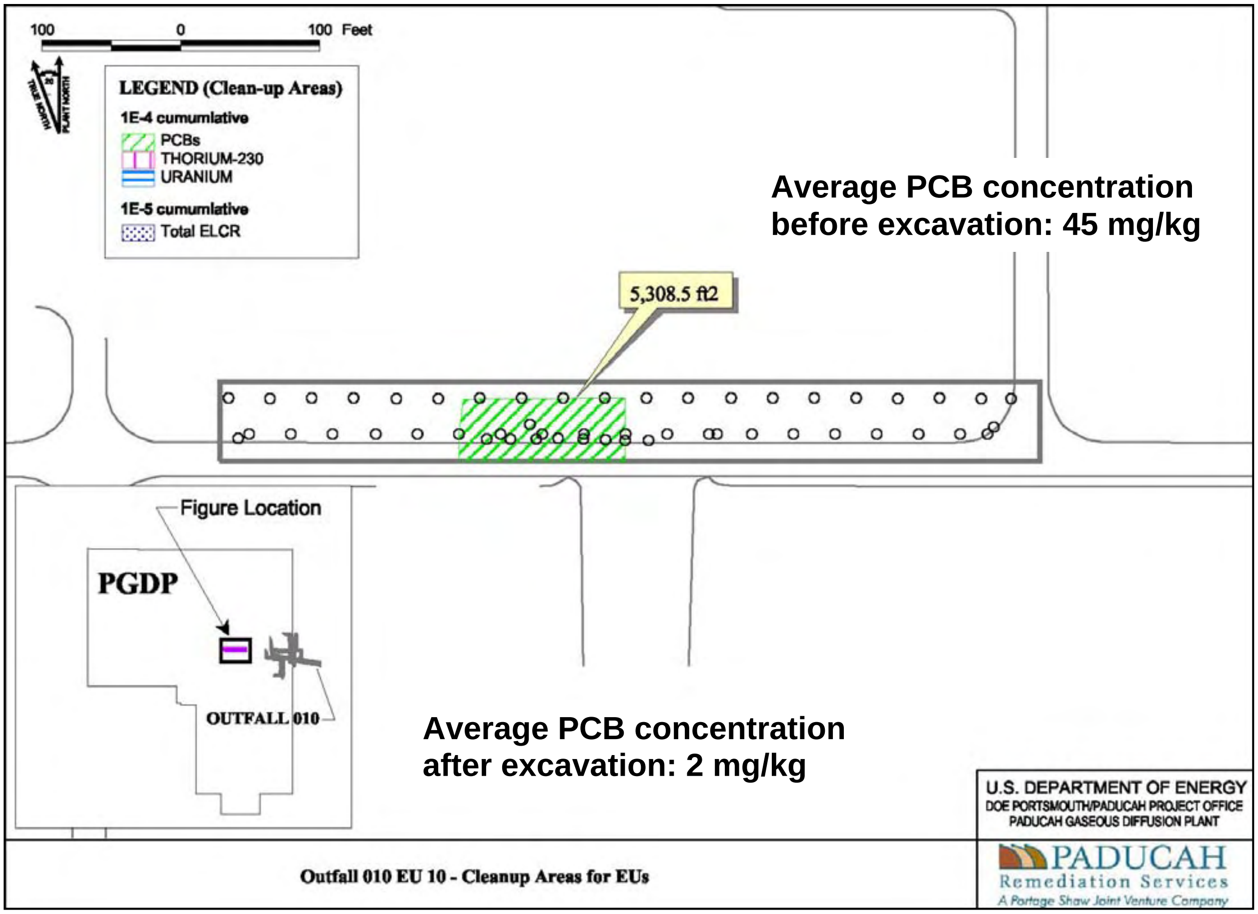


Figure F.4. Outfall 010 Cleanup Area

Table F.5. Cumulative ELCR for "Hot Spots" Requiring Cleanup within the SWOU

Location	Exposure Unit	Driving COC	ELCR Prior to Excavation	ELCR After 1E-5 Cleanup
Outfall 001	15	PCB	1.74E-05	0
Outfall 008	11	PCB	2.35E-05	0
Outfall 010	10	PCB	1.92E-04	0
Outfall 015	2	ELCR	1.28E-04	0
Outfall 015	4	ELCR	1.28E-05	0
Outfall 015	8	PCB	8.23E-05	0
NSDD Section 3	1	PCB	1.50E-05	0
NSDD Section 3	2	ELCR	1.18E-05	0
NSDD Section 3	2	Thorium-230	3.26E-05	0
NSDD Section 3	3	ELCR	1.70E-05	0
NSDD Section 5	8	ELCR	1.07E-05	0

F.1.7 Field implementation

Examples of chemical concentrations that might be used for verification of attainment of the risk-based target of a cumulative ELCR of 1E-05 and a cumulative hazard index of 1.0 are discussed below. These concentration targets are intended to verify attainment of the risk- and hazard-based targets at the excavated depth. The final chemical concentrations to be selected will be presented in the subsequent Removal Action Work Plan.

Implementation of the recommended alternative, which would include excavation of "hot spots" identified at a cumulative ELCR of 1E-05, would include verification sampling. To ensure that the residual cumulative ELCR would be equal to or below the ELCR target of 1E-05, concentrations for COCs used in verification sampling were calculated using a chemical-specific target of 5E-06. The concentrations for some COCs are listed in Table F.6.

Table F.6. Examples of Chemical-Specific Verification Targets for Some COCs

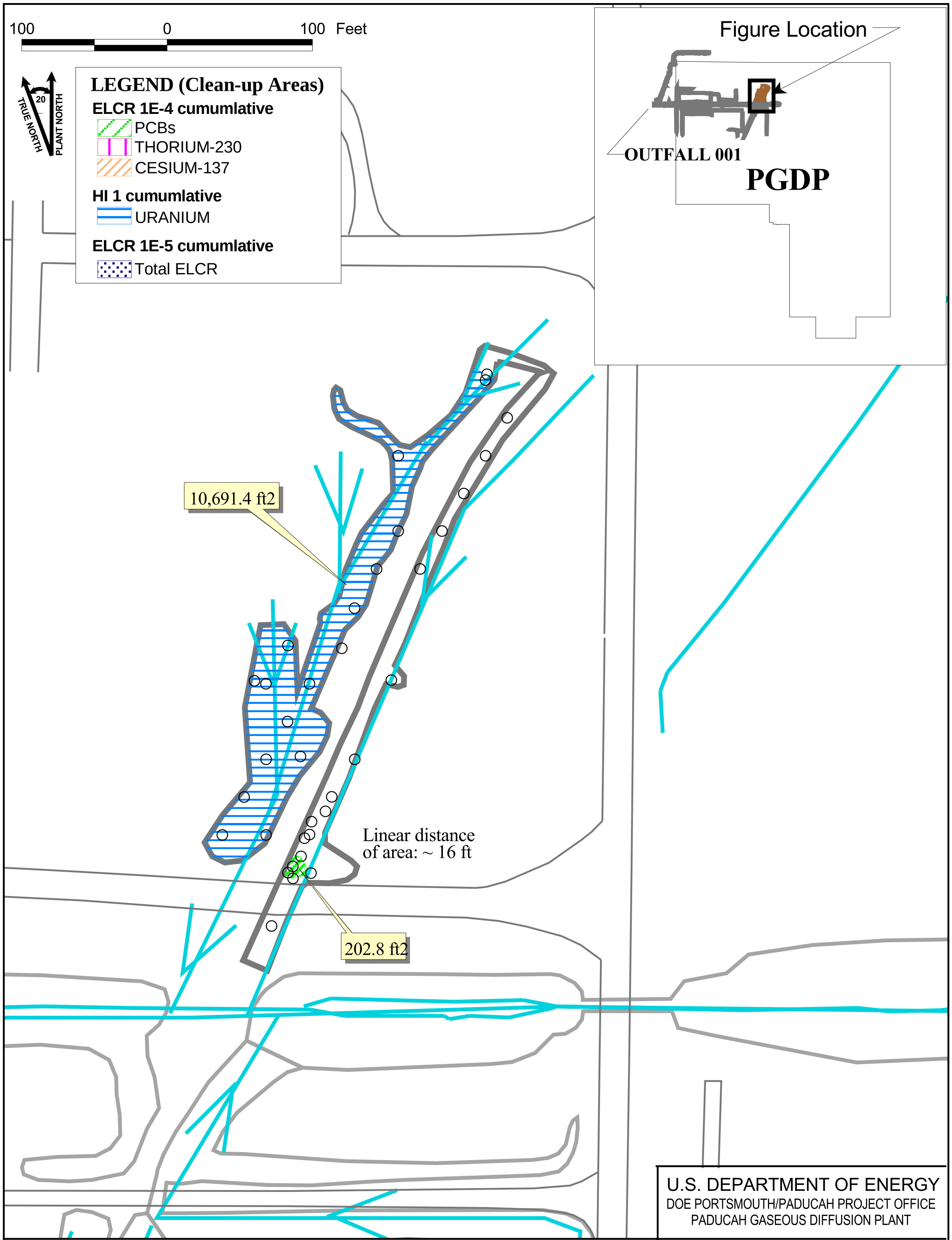
COC	PRG
	mg/kg
Arsenic	27
Total PCB	16
Uranium	227
	pCi/g
Cesium-137	7.6
Thorium-230	150

Maps showing "hot spots" to be excavated under the recommended alternative at a cumulative ELCR target of 1E-05 are shown in Appendix F, Attachment 1. These maps also include "hot spots" identified for cleanup based upon hazard posed by uranium.

ATTACHMENT F1

RISK-BASED COST-BENEFIT MAPS

THIS PAGE INTENTIONALLY LEFT BLANK

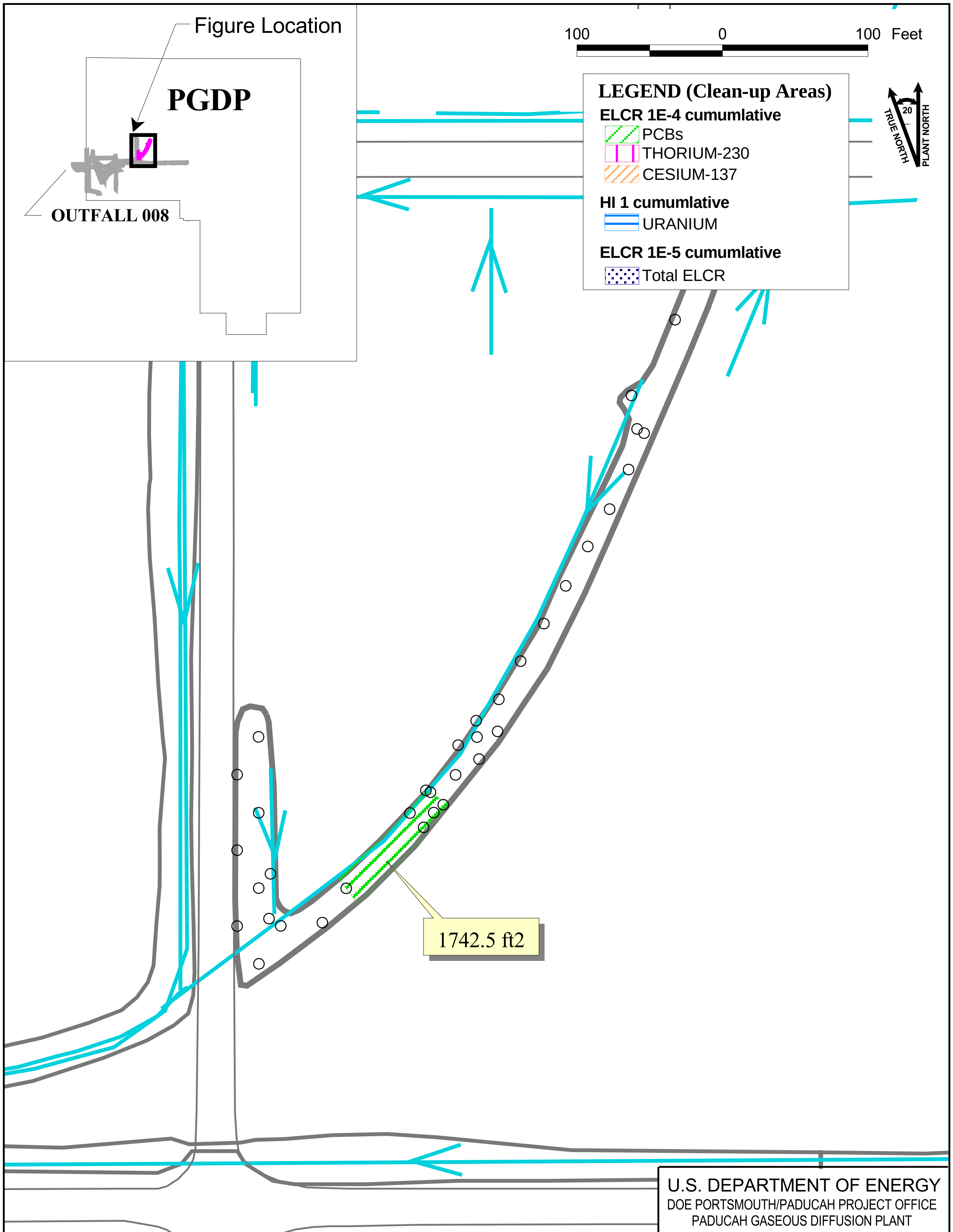


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Outfall 001 EU 15 - Cleanup Areas for EUs

PADUCAH
Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08

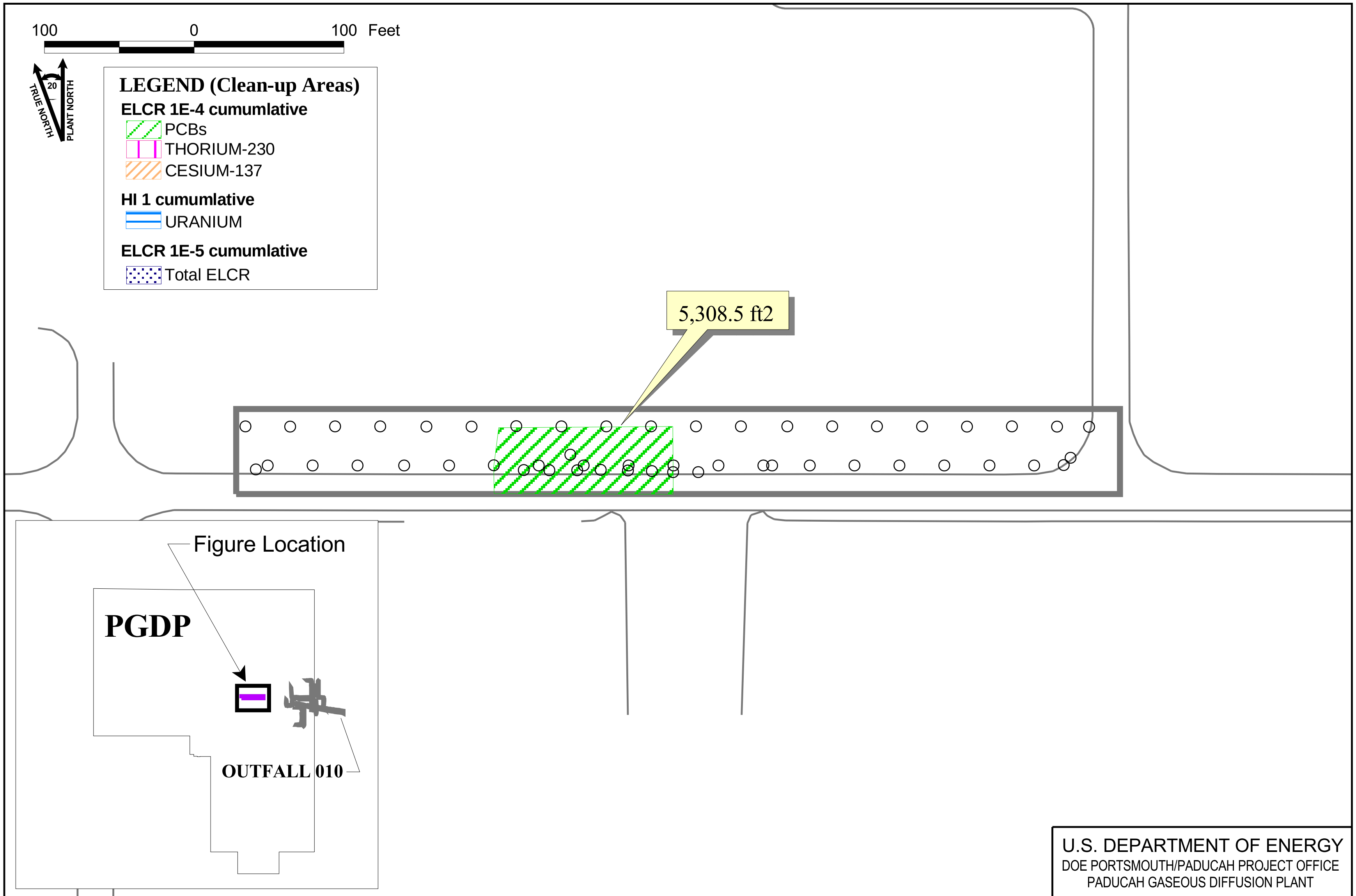


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Outfall 008 EU 11 - Cleanup Areas for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08

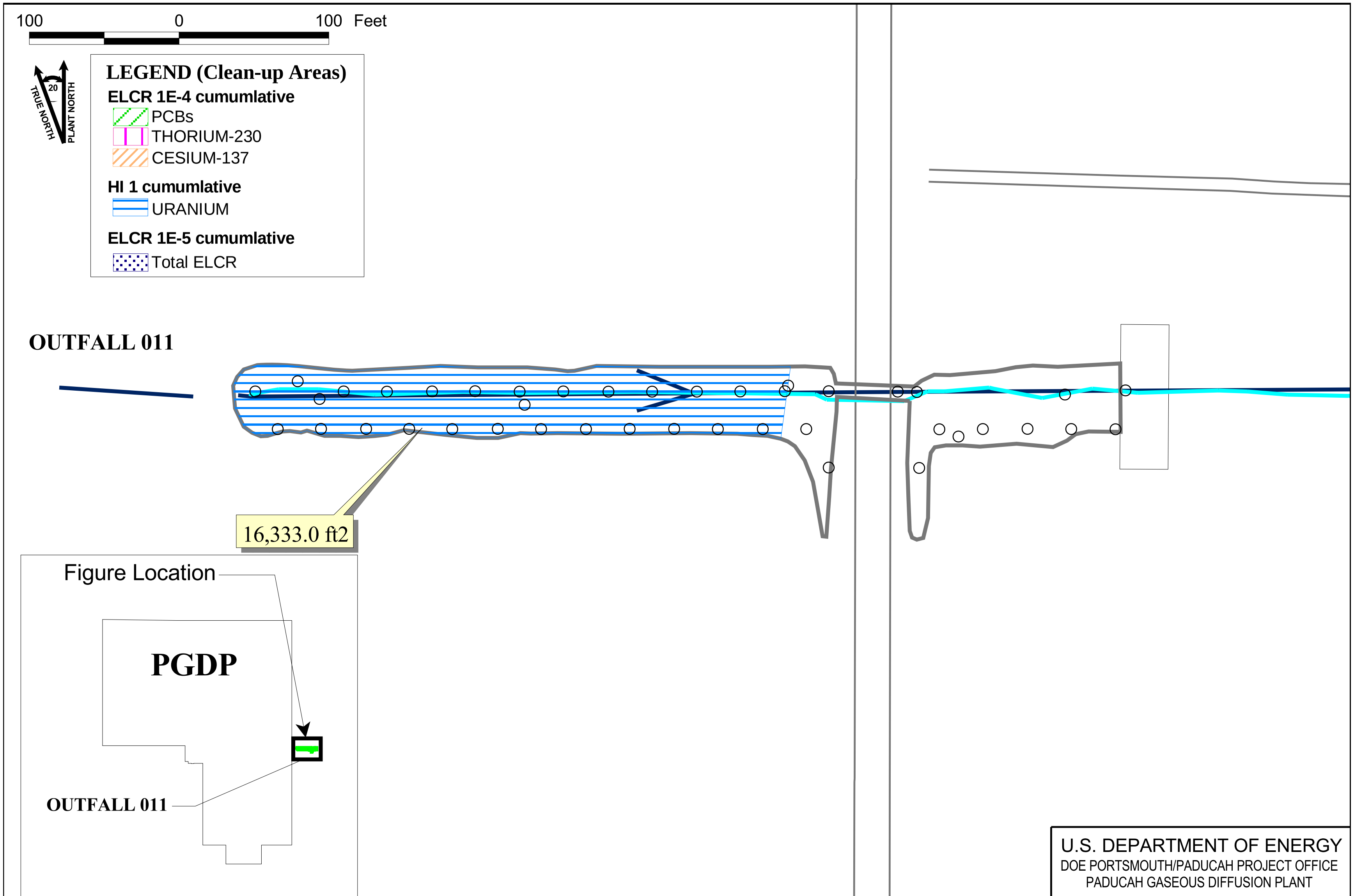


Outfall 010 EU 10 - Cleanup Areas for EUs

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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08

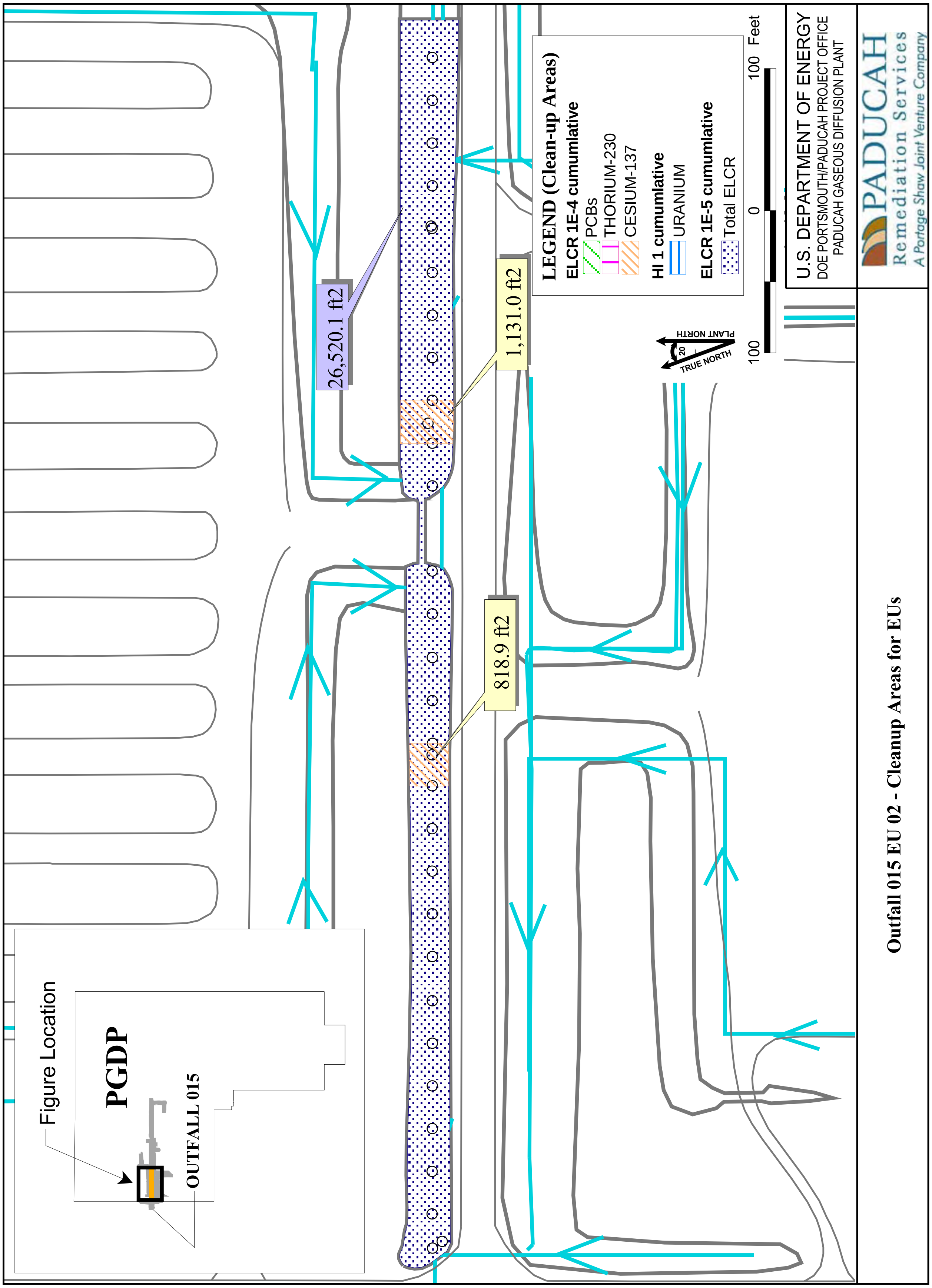


Outfall 011 EU 01 - Cleanup Areas for EUs

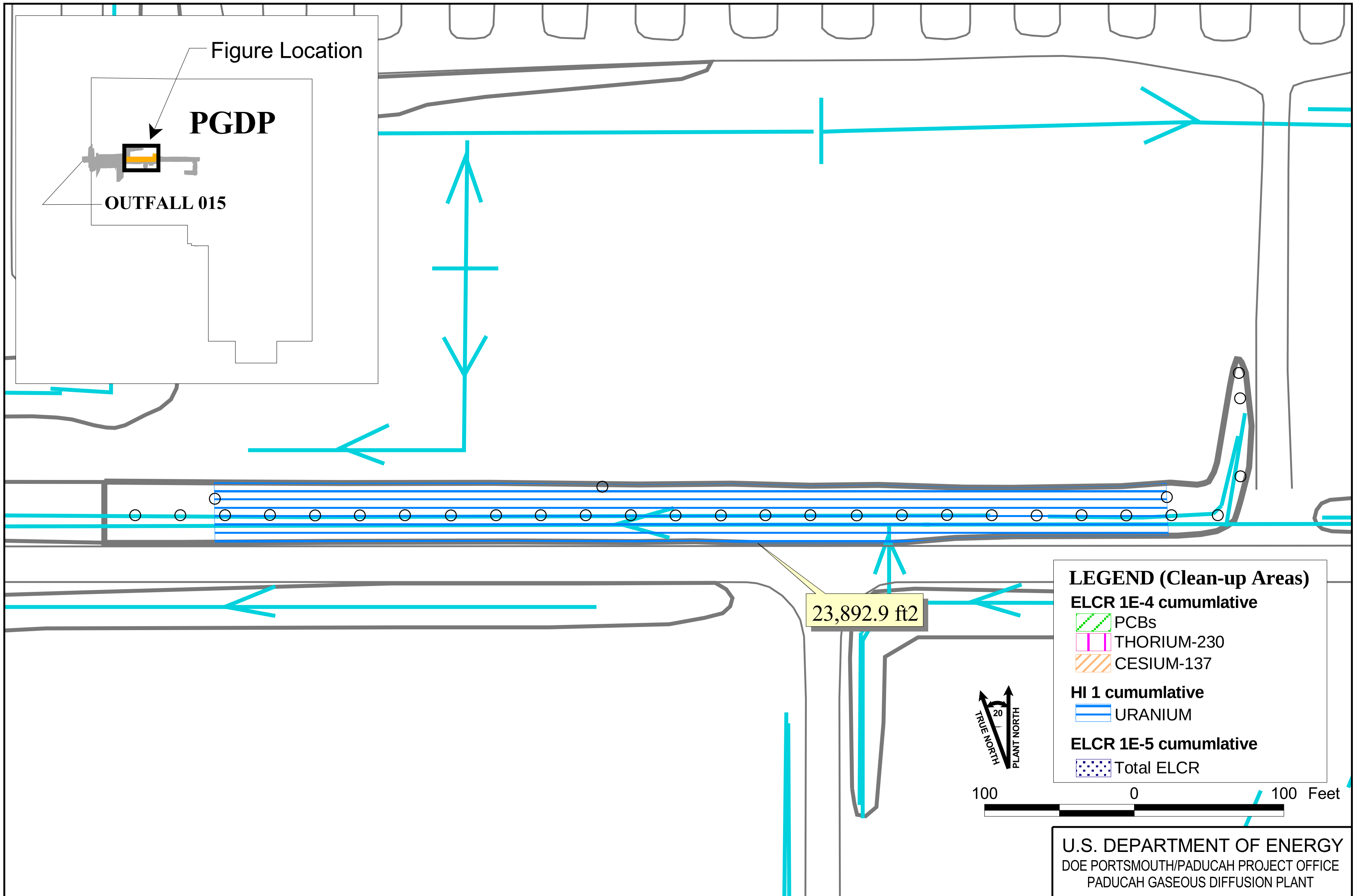
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08



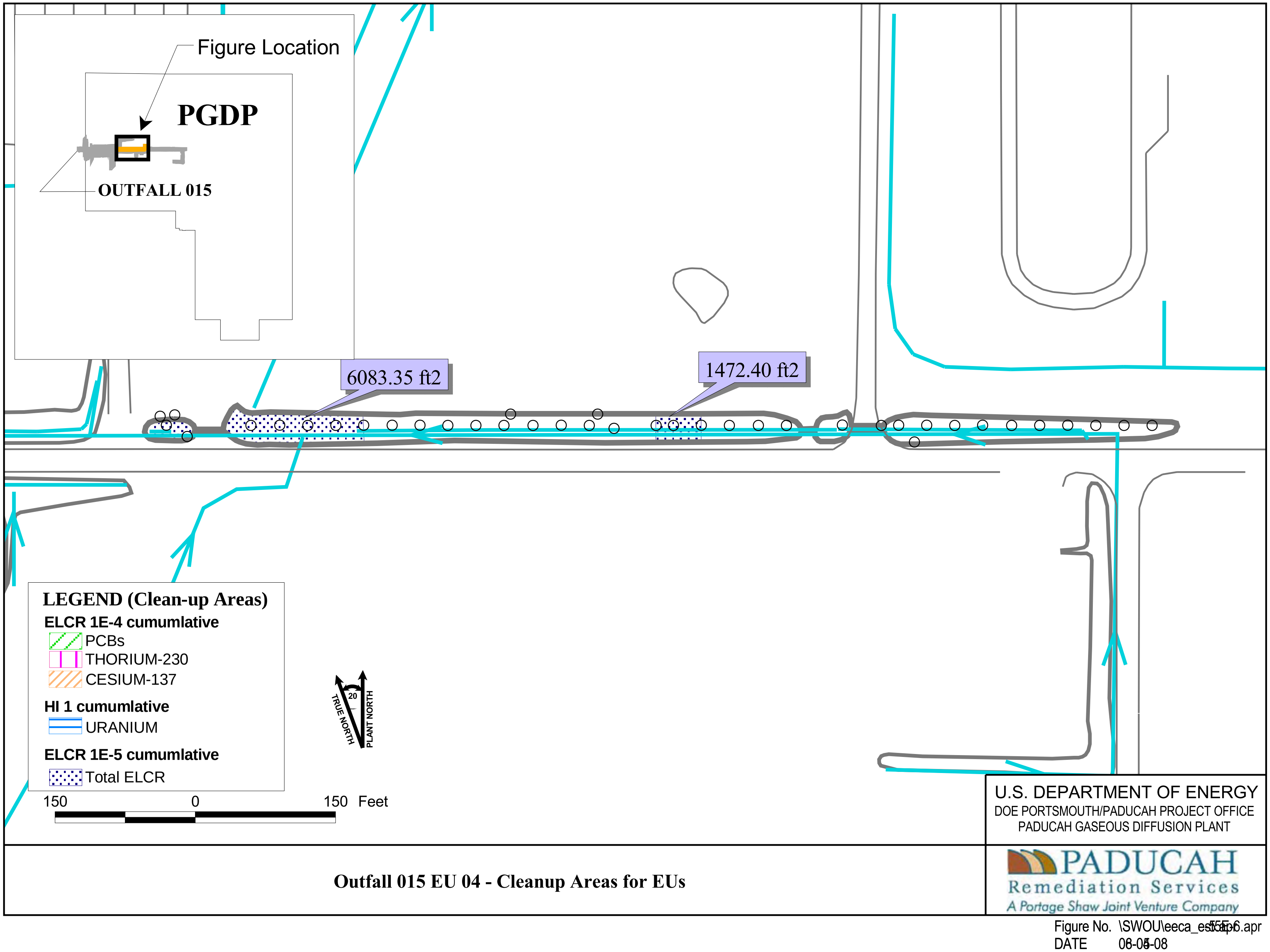
Outfall 015 EU 02 - Cleanup Areas for EUs



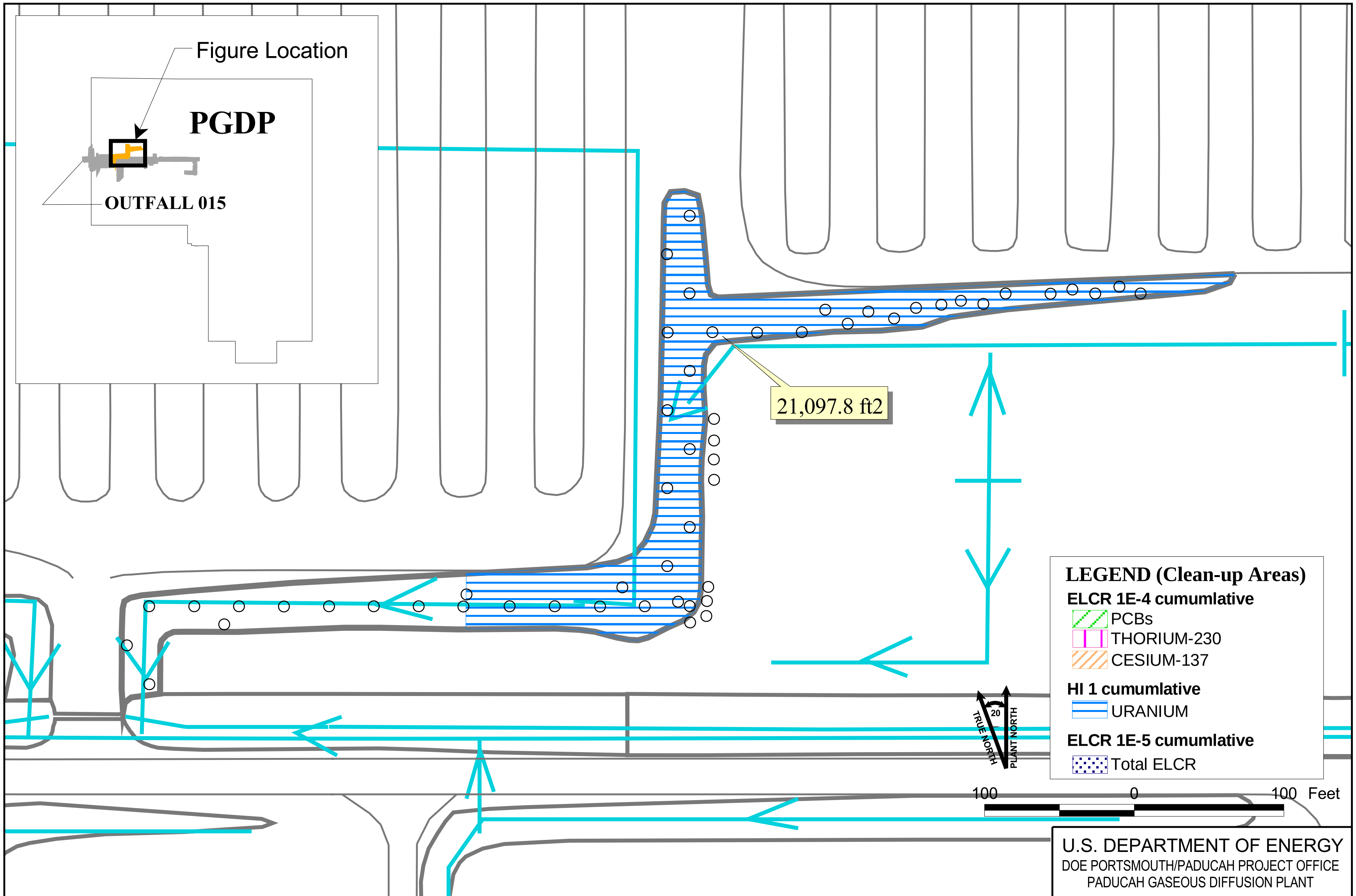
Outfall 015 EU 03 - Cleanup Areas for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08



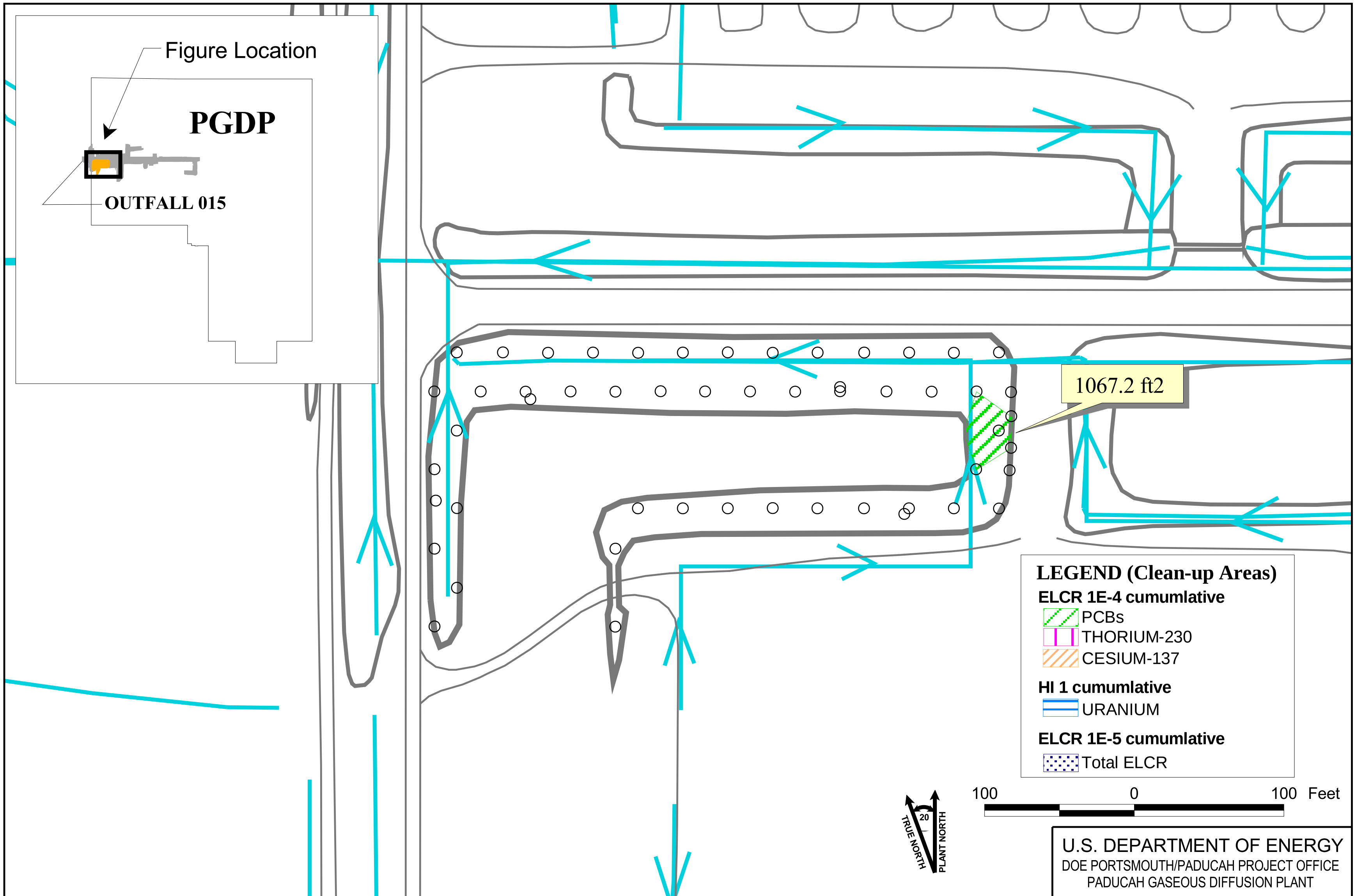
Outfall 015 EU 04 - Cleanup Areas for EUs



Outfall 015 EU 07 - Cleanup Areas for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_e-5.apr
DATE 08-04-08

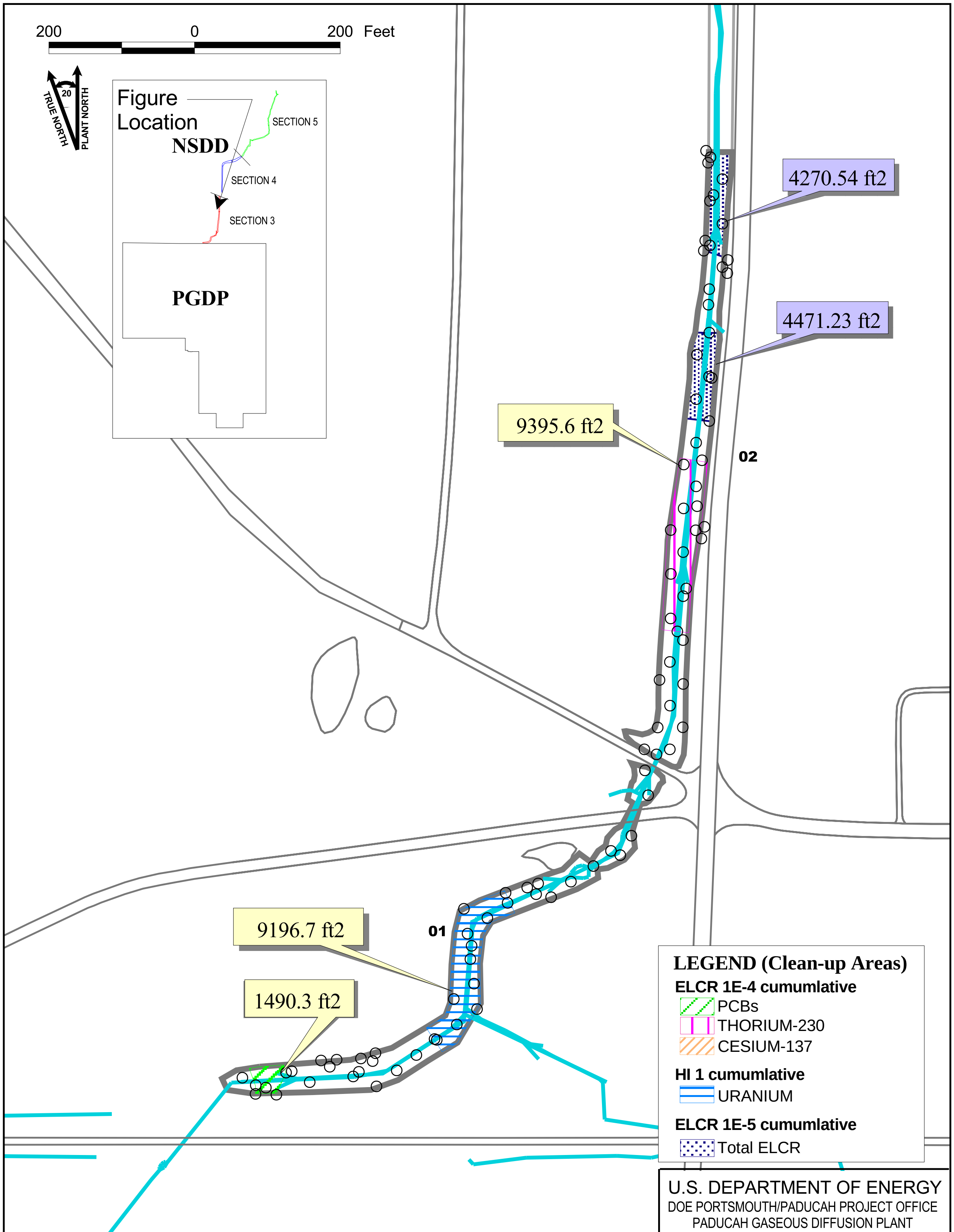


Outfall 015 EU 08 - Cleanup Areas for EUs

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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \SWOU\eeca_es55ep6.apr
DATE 06-04-08

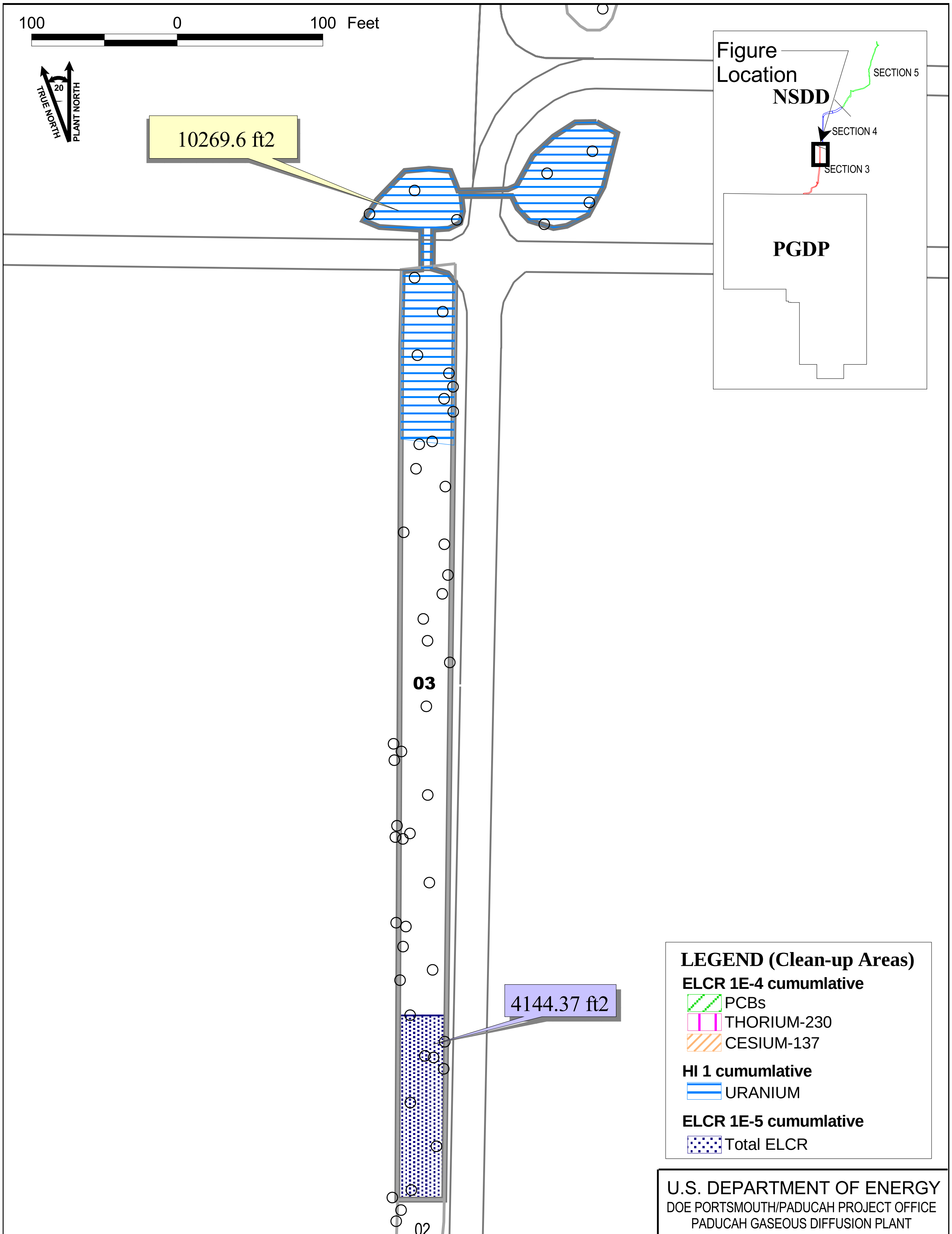


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

NSDD Section 3 EUs 01 and 02 - Cleanup Areas for EUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. eecansdd_e-5.apr
DATE 08-04-08

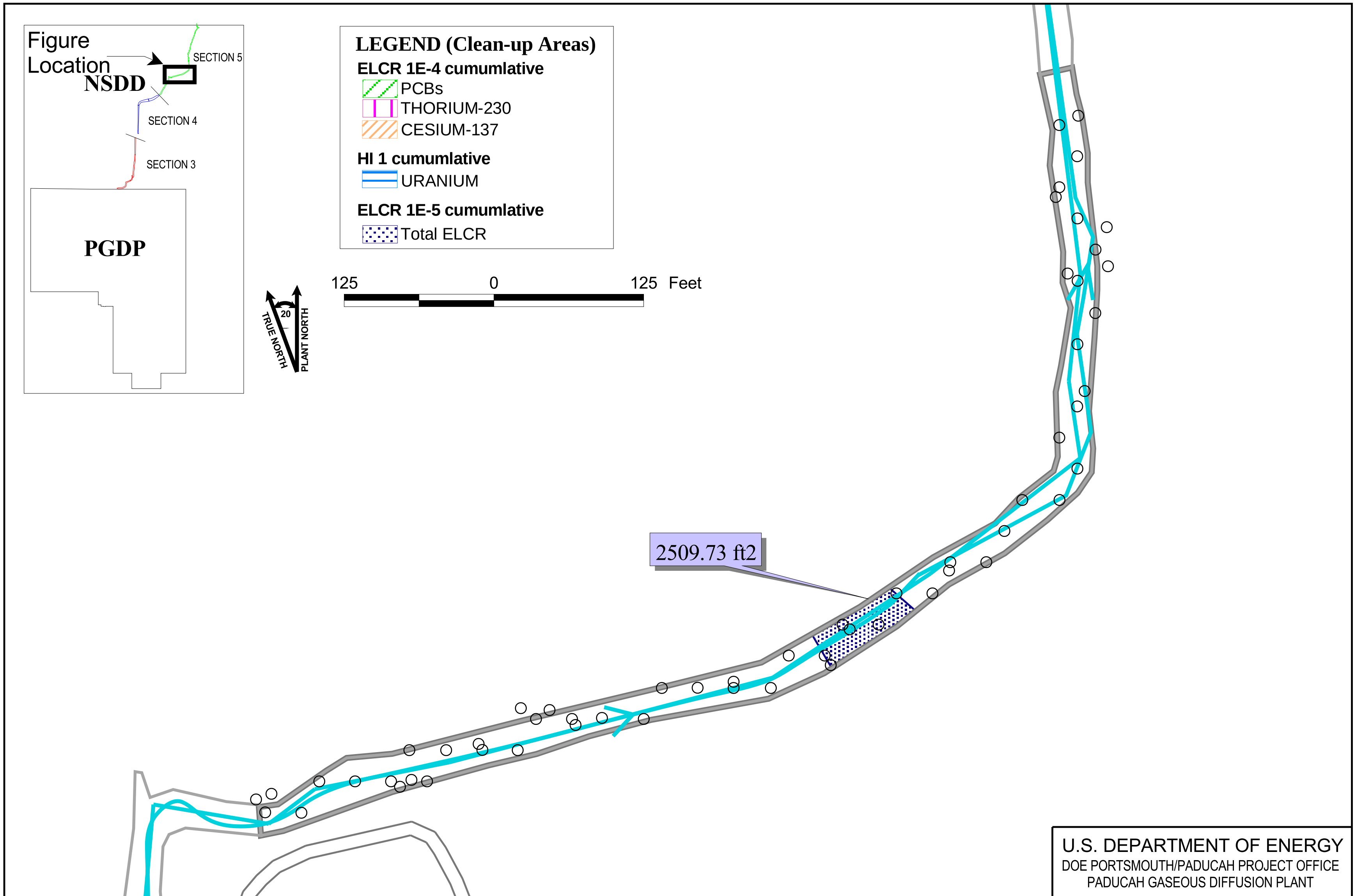


U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

NSDD Section 3 EU 03 - Cleanup Area

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. eecansdd_e-5.apr
DATE 08-04-08



NSDD Section 5 EU 08 - Cleanup Area

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

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. eecansdd_e-5.apr
DATE 08-04-08