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Primary Document

Engineering Evaluation/Cost Analysis for Site-Wide Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

I-04812-0087

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Science Applications International Corporation

Contributed to the preparation of this document and should not be considered an eligible contractor for its review.

CERTIFICATION

Document Identification: ***Engineering Evaluation/Cost Analysis for Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** **(DOE/OR/07-1958&D1/R1)**

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

U.S. Department of Energy (DOE)
Owner and Operator

W. Don Seaborg, Paducah Site Manager

2/8/02
Date Signed

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Bechtel Jacobs Company LLC
Co-Operator

Gordon L. Dover, Paducah Manager of Projects

2/8/02
Date Signed

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Engineering Evaluation/Cost Analysis for Site-Wide Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—February 2002

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

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
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PREFACE

This *Engineering Evaluation/Cost Analysis (EE/CA) for Site-Wide Sediment Controls at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1958&D1/R1, is a site-wide removal action prepared to evaluate removal action alternatives in compliance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act. The alternatives considered address the prevention of the potential discharge of contaminated sediments and the minimization of sediment discharge from Outfalls 001, 008, 010, 011, and 015 when existing conditions or future planned activities have the potential to mobilize contaminants that could contribute to risks to downstream receptors. The potential for surface water discharge of dissolved phase contaminants or contaminated sediments that exceed human health risk levels of 1×10^{-4} for a child recreator and ecological risk levels of a hazard index of 3 could exist at these five outfalls if specific situations were to occur. These situations include excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls); infrequent off-normal conditions, such as maintenance activities, when existing runoff and sediment control measures are inoperable; the remediation of upgradient solid waste management units (SWMUs) within the watershed that could disturb and mobilize contaminated surface and shallow subsurface soil and, therefore, represent the potential for surface water discharge of contamination; or the occurrence of new upgradient contamination with the potential for off-site transportation via storm runoff.

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(s) that best meet the removal action objectives. The sediment control measures proposed for implementation would be maintained for as long as necessary to support ongoing active site remediation. For design purposes, it is assumed that the alternatives would have a 30-year life span. 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.

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CONTENTS

PREFACE iii
FIGURES vii
TABLES ix
ACRONYMS xi
EXECUTIVE SUMMARY e5-1

1. INTRODUCTION 1-1
   1.1 SITE DESCRIPTION AND BACKGROUND 1-1
      1.1.1 Regional Topography 1-3
      1.1.2 Land Use and Population 1-3
      1.1.3 Climate 1-4
      1.1.4 Geology 1-4
      1.1.5 Hydrogeology 1-9
      1.1.6 Ecology 1-12
   1.2 SITE-WIDE SEDIMENT CONTROLS PROJECT CORE TEAM STRATEGY 1-14
   1.3 ANALYTICAL DATA 1-16
   1.4 PREVIOUS INVESTIGATIONS AND RESPONSE ACTIONS 1-18
      1.4.1 West Side Outfalls 1-18
      1.4.2 East Side Outfalls 1-25
   1.5 SOURCE, NATURE, AND EXTENT OF CONTAMINATION 1-32
      1.5.1 Assessment of Category 1 Outfalls 1-32
   1.6 STREAMLINED RISK EVALUATION 1-60
      1.6.1 Human Health Risk 1-62
      1.6.2 Ecological Risk 1-63
   1.7 COMMUNITY PARTICIPATION 1-64

2. REMOVAL ACTION OBJECTNES 2-1
   2.1 RESPONSE AUTHORITY 2-1
   2.2 REMOVAL SCOPE AND PURPOSE 2-1
   2.3 REMOVAL ACTION OBJECTIVES 2-2
   2.4 JUSTIFICATION FOR THE PROPOSED ACTION 2-2
      2.4.1 Outfall 001 2-2
      2.4.2 Outfall 008 2-3
      2.4.3 Outfall 010 2-3
      2.4.4 Outfall 011 2-3
      2.4.5 Outfall 015 2-3

3. REMOVAL ACTION TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES 3-1
   3.1 RESPONSE ACTION DEVELOPMENT 3-1
      3.1.1 Localized Controls 3-2
      3.1.2 Integrated Controls 3-2
      3.1.3 System Controls 3-2
      3.1.4 Review of Process Water Contribution to Outfall Discharge 3-3
   3.2 ALTERNATIVES TO BE EVALUATED 3-5
   3.3 MONITORING OF ALTERNATIVES 3-5

4. ANALYSIS OF ALTERNATIVES....4-1
4.1 ANALYSIS CRITERIA....4-1
4.1.1 Effectiveness....4-1
4.1.2 Implementability....4-1
4.1.3 Costs....4-2
4.2 ANALYSIS OF INDIVIDUAL ALTERNATIVES....4-2
4.2.1 Alternative 1 – No Sediment Control Measures (No Action)....4-2
4.2.2 Alternative 2 – Localized Controls and Integrated Controls....4-3
4.2.3 Alternative 3 – Localized Controls, Integrated Controls, and System Controls (New Outfall Ditches)....4-7
4.2.4 Alternative 4 – Localized Controls, Integrated Controls, and System Controls (New Outfall Ditches and Sedimentation Basin)....4-11
4.3 COMPLIANCE WITH ARARS....4-19
4.4 COMPARATIVE ANALYSIS OF ALTERNATIVES....4-20
4.4.1 Effectiveness....4-20
4.4.2 Implementability....4-25
4.4.3 Cost....4-25

5. RECOMMENDED REMOVAL ACTION ALTERNATIVE....5-1

6. REFERENCES....6-1

APPENDIX A RISK TABLES....**A-1**

APPENDIX B COST ESTIMATE AND CONCEPTUAL BASIN DESIGN....B-1

APPENDIX C POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS....C-1

FIGURES

1.1 PGDP vicinity map. Paducah Gaseous Diffusion Plant. Paducah. Kentucky 1-2
1.2 Physiographic provinces for the Commonwealth of Kentucky 1-6
1.3 Generalized geologic cross-section for the PGDP 1-7
1.4 Lithostratigraphic column of the Jackson Purchase Region ..... . I -8
1.5 Surface water features in the vicinity of PGDP 1-10
1.6 KPDES Outfall locations and generalized surface water flow patterns at PGDP 1-11
1.7 Conceptual model of Outfall 001 1-19
1.8 Conceptual model for Outfall 008 1-21
1.9 Conceptual model of Outfall 015 ..... . I -24
1.10 Diagram of operation of Outfall Ditches 002, 010. 011. 012. and 013 at PGDP 1-26
1.11 Conceptual model of Outfall 010 1-28
1.12 Conceptual model of Outfall 011 1-30
1.13 Sampling locations within Outfall 001 watershed ..... . I -33
1.14 SWMU locations and exceedances of the child recreator action level within Outfall 001 watershed I-36
1.15 Sampling locations within Outfall 008 watershed I-39
1.16 SWMU locations and exceedances of the child recreator action level within Outfall 008 watershed 1-43
1.17 Sampling locations within Outfall 010 watershed 1-45
1.18 SWMU locations and exceedances of the child recreator action level within Outfall 010 watershed 1-47
1.19 Sampling locations within Outfall 011 watershed 1-50
1.20 SWMU locations and exceedances of the child recreator action level within Outfall 011 watershed 1-53
1.21 Sampling locations within Outfall 015 watershed I-56
1.22 SWMU locations and exceedances of the child recreator action level within Outfall 015 watershed ..... . I -59
4.1 Outfall 008 sediment basin 4-16

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TABLES

1.1 Thirteen-year average for precipitation and temperature. Barkley Regional Airport. Paducah. Kentucky 1-5
1.2 Federally listed. proposed. and candidate species potentially occurring within PGDP area 1-14
1.3 Inorganic chemicals (mg/kg) and radionuclides (pCi/g) found at concentrations above provisional background in outfall soils and sediments 1-17
1.4 Test Results of the Nature's Way Bioremediation Technology Field Demonstration..... 1-31
1.5 Summary of dataset for balance of Outfall 001 1-34
1.6 Outfall 001 – Comparison of analyte detections in sediment and soil to child recreator action levels 1-35
1.7 Balance of Outfall 001 Technical Response 1-38
1.8 Summary of dataset for Outfall 008..... 1-40
1.9 Outfall 008 – Comparison of analyte detections in sediment and soil to child recreator action levels 1-41
1.10 Outfall 008 Technical Approach..... 1-44
1.11 Summary of dataset for Outfall 010..... 1-46
1.12 Outfall 010 Technical Approach..... 1-49
1.13 Summary of dataset for of Outfall 011 1-51
1.14 Outfall 011 – Comparison of analyte detections in sediment and soil to child recreator action levels 1-52
1.15 Outfall 011 Technical Approach..... 1-55
1.16 Summary of dataset for Outfall 015..... 1-57
1.17 Outfall 015 – Comparison of analyte detections in sediment and soil to child recreator action levels 1-58
1.18 Outfall 015 Technical Approach..... .1-61
4.1 Comparison of major differences in estimated construction cost differences for the two possible Outfall 008 basin locations 4-17
4.2 Removal action alternative comparisons 4-21

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ACRONYMS

amsl	above mean sea level
AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CAB	Citizens Advisory Board
COE	U.S. Army Corps of Engineers
DI/FURA	dioxin/furans
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EE/CA	Engineering Evaluation/Cost Analysis
EM	Environmental Management
EPA	U. S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
GWOU	groundwater operable unit
ha	hectare
HI	hazard index
HF	hydrofluoric acid
IW	industrial worker
KDFWR	Kentucky Department of Fish and Wildlife Resources
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
LCB	Lifecycle Baseline
LCD	Lower Continental Deposits
LMES	Lockheed Martin Energy Systems, Inc.
mgpd	million gallons per day
mlpd	million liters per day
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFA	No Further Action
NOV	Notice of Violation
NPL	National Priorities List
NSDD	North South Diversion Ditch
O&M	operation and maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	pentachlorodibenzodioxin
PGDP	Paducah Gaseous Diffusion Plant
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
RAO	Removal Action Objective
RAWP	Removal Action Work Plan

RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RI	remedial investigation
SI	site investigation
SOU	soils operable unit
SVOA	semivolatile organic aromatic
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
SWSC PCT	Site-Wide Sediment Controls Project Core Team (DOE, EPA, and Commonwealth of Kentucky)
T&E	threatened and endangered
TBC	to be considered
TCDD	tetrachlorodibenzodioxin
TCE	trichloroethene
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TVA	Tennessee Valley Authority
UCD	Upper Continental Deposits
UCRS	Upper Continental Recharge System
UF4	uranium tetrafluoride
UF6	uranium hexafluoride
USEC	United States Enrichment Corporation
USV	upper screening value
VOA	volatile organic aromatic
WAG	Waste Area Group
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP), an active uranium enrichment facility owned by the U.S. Department of Energy (DOE), is located in western Kentucky, approximately 16 km (10 miles) west of Paducah, Kentucky. DOE, the U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky have agreed that preventing off-site migration of contaminants is the highest site-wide priority for nonemergency cleanup activities at the Paducah Gaseous Diffusion Plant (PGDP), and that containment/prevention/minimization of potential surface water discharges of contaminants from PGDP is the highest priority for the Surface Water Operable Unit (SWOU). The SWOU is one of four operable units (OUs) at the PGDP being used to evaluate and implement remedial actions. The general scope and role of the SWOU is to focus on contaminated media that primarily contain or cause surface water and associated sediment contamination. The SWOU consists of 52 source units [i.e., solid waste management units (SWMUs) and areas of concern (AOCs)] that are being evaluated as part of the ongoing OU Remedial Investigation (RI)/Feasibility Study (FS) activities.

Surface water discharges from PGDP are released to Bayou and Little Bayou Creek via 17 outfall ditches. To prioritize the assessment and response activities required to contain the potential discharge of contaminated sediment from these outfalls, the Site-Wide Sediment Controls Project Core Team (SWSC PCT) consisting of representatives of DOE, EPA, and the Commonwealth of Kentucky met periodically during 2001 and 2002. During these meetings, the SWSC PCT considered recommendations made by the Paducah Citizens Advisory Board (CAB) to develop a site-wide surface water management strategy and conducted preliminary assessments of the 12 outfalls designated as SWMUs. As a result of these assessments, Outfalls 008, 010, 011, 015, and that portion of Outfall 001 not addressed by storm water runoff and sediment control measures instigated as part of the Scrap Metal Disposition project (DOE 2001) were determined to need action based on existing information and planned near-term (i.e., within 2 years) remediation of upgradient SWMUs.

This Engineering Evaluation/Cost Analysis (EE/CA) documents and describes the evaluation of alternatives to address the potential threat to human health and the environment resulting from the release or potential release of hazardous materials associated with storm water runoff or contaminated sediment discharge from these five outfalls. This EE/CA was prepared in accordance with EPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993) and represents an early action to address site-wide sediment controls as part of the SWOU. Monitoring and further assessment of contamination in the SWOU will be performed prior to defining any final action for this OU. This early action is the last planned removal action for the SWOU prior to beginning remedial evaluation and cleanup.

Outfalls 001, 008, and 015 are located on the west side of PGDP and drain to Bayou Creek. Outfalls 010 and 011 are located on the east side of PGDP and drain to Little Bayou Creek. These outfalls receive surface water runoff and wastewater from various permitted sources within PGDP. The water quality of each outfall is regulated by a Kentucky Pollutant Discharge Elimination System (KPDES) permit and water quality is tested regularly at established monitoring stations, in accordance with the conditions of the permits. Regular KPDES monitoring of these outfalls has resulted in four Notices of Violation (NOVs) during the past 10 years: PCB-1248, PCB-1260, and Total PCBs at Outfall 011 (two times in 1994); total residual chlorine at Outfall 008 and at 001 (both in 1997); and whole effluent toxicity limit at Outfall 001 (1999).

Outfall 001 receives drainage from an area of about 82.1 hectares (ha) (203 acres). The sediment control measures discussed in this document would provide containment of sediment mobilized from that portion of Outfall 001 [61.7 ha (152.5 acres)] not addressed in *the Engineering Evaluation/Cost Analysis (EE/CA) for Scrap Metal Disposition at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001). Facilities that drain into the portion of Outfall 001 discussed in this document include the following: the

C-335 Process Building; the C-337 Process Building; the C-337-A Vaporizer (SWMU 71); and the C-400 Cleaning Building; C-410 Feed Plant and Appurtenant Structures (C-411 Cell Maintenance Building, C-415 Feed Plant Storage Building, and the C-420 Greensalt Plant); the C-600 Steam Plant and Supporting Facilities. Previous investigations to characterize contaminant levels in the sediments of Outfall 001 have identified radionuclides [technetium-99(^{99}Tc), uranium-234, uranium-238, plutonium-239, and thorium-230]. Radionuclides (^{99}Tc, uranium-234, and uranium-238) also were detected in the surface water within Outfall 001.

Outfall 008 receives drainage from an area of approximately 36.52 ha (90.4 acres) that encompasses the C-615 Sewage Disposal Plant, Collection System and Appurtenant Structures (C-615-A Primary Settling Tank, C-615-B Final Settling Tank, C-615-C Control Building, C-615-D Digester, C-615-E Trickling Filter, and the C-615-F Sludge Beds) (SWMU) 38), the C-747-C Oil Landfarm (SWMU 1), the C-745-A and C-746-H Cylinder Storage Yards, the C-747 Burial Yard. In addition, Outfall 008 receives all water discharged from Outfall 004 and storm sewer discharges of storm water runoff from the C-310 Purge and Product Building; the C-331 Process Building; the C-400 Cleaning Building; the C-402 Cleaning Building; the C-409 Stabilization Building; the C-410 Feed Plant; the C-411 Cell Maintenance Building; the C-420 Greensalt Plant; the C-600 Steam Plant and Supporting Facilities; the C-615 Sewage Disposal Plant; the C-720 Maintenance and Stores Building; the C-721 Gas Manifold Storage; the C-724 Cleaning Facility; the C-729 Acetylene Building; the C-741 Mobile Equipment Building; the C-742 Cylinder Storage Building; the C-743 Office Building and the C-744 Lubrication Building. Previous investigations to characterize contaminant levels in the sediments of Outfall 008 have identified radionuclides (plutonium-239, ^{99}Tc, uranium-234, and uranium-238. Radionuclides (^{99}Tc, uranium-234, and uranium-238) also were detected in the surface water at Outfall 008.

Outfall 010 receives drainage from an area of about 8.78 ha (22 acres) encompassing the C-331 Process Building, the C-531 area [including the C-531-1 Switch House and Appurtenant Structures (C-531-3A and C-531-B Fire Valve Houses), the C-531-2 Electrical Switchyard (**SWMU** 82)], the C-617-B Lagoon, the C-746-D Scrap Yard (SWMU 16), and the C-746-E Cylinder Storage Yard. The C-331 Process Building also drains to the Outfall via the storm sewer system. Previous investigations of the contaminants present in the sediment at Outfall 010 have identified dioxins, polychlorinated biphenyls (PCBs), and metals. Radionuclides (^{99}Tc) and organic contaminants (trichloroethene) also were detected in the surface water at Outfall 010.

Outfall 011 receives drainage from an area of approximately 12.5 ha (31 acres) encompassing the C-315 Surge and Waste Building; the C-331 and C-333 Process Buildings; the C-340 Reduction and Metals Facility; the C-352 Relay House; and the C-533 Switch House. Previous investigations to characterize contaminant levels in the sediments of Outfall 011 have identified radionuclides (^{99}Tc, thorium-230, uranium-234, uranium-235, and uranium-238); organic contaminants; metals contamination (chromium, copper, zinc, and nickel); and PCBs (PCB-1248, PCB-1254, and PCB-1260). Past exceedances of PCB-1248, PCB-1260, and total PCBs have been identified in the surface water at Outfall 011. Surface water discharges from Outfall 011 are collected in a sump and pumped to the C-617-B Treatment Lagoon for treatment prior to discharge to Little Bayou Creek via Outfall 010.

Outfall 015 receives drainage from an area of approximately 19.8 ha (49 acres) encompassing the C-400 Cleaning Building; the C-405 Contaminated Items Incinerator (SWMU 55); the C-616-L Pipeline and Vault Soil Contamination (SWMU 165); the C-749 Uranium Burial Ground (**SWMU** 2); the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground (SWMU 3); the C-745-A Cylinder Storage Yard; the C-747 Burial Grounds (SWMU 4); the UF_6 Cylinder Drop Test Area (SWMU 91); the C-745-B Cylinder Storage Yard; and some of the C-745-C cylinder yards. Previous investigations of sediment contaminants at Outfall 015 have identified radionuclides (^{99}Tc, uranium-234, thorium-230, plutonium-235, uranium-235, and uranium-238) and metal contamination (aluminum, cobalt, copper, thallium, and zinc).

The results of the human health screening risk assessment performed for this EE/CA indicate that contaminants are present in the sediments and soils of the watersheds of Outfalls 001,008,010,011, and 015 at concentrations that exceed the human health action levels (i.e., at a concentration greater than screening levels derived using an excess lifetime cancer risk of 1×10^{-4} and a hazard index of 3) for an industnal worker and a child recreator; however the number of detections at concentrations above the action levels is infrequent. The chemicals and compounds in soils and sediments at Outfall 001 exceeding the industrial worker and child recreator action levels include several PCB mixtures and radionuclides. The chemicals and compounds in soils and sediments at Outfall 008 exceeding the industrial worker and child recreator action levels include 2,3,7,8-tetrachlorodibenzodioxin (TCDD) (i.e., a dioxin), benzo(a)pyrene [i.e., a polycyclic aromatic hydrocarbon **(PAH)],** and several PCB mixtures. None of the chemicals or compounds in soils or sediments exceeded the industrial worker or child recreator action levels at Outfall 010. The chemicals and compounds in soils and sediments at Outfall 011 exceeding the industrial worker and child recreator action levels are PAHs, several PCB mixtures, pentachlorodibenzodioxin (PCDD) (i.e., dioxin), and uranium-238. The only chemical in soil and sediments at Outfall 015 that exceeds the industnal worker and child recreator action levels is cesium-137. The only detection in surface water that exceeds an action level is from Outfall 011. The chemical exceeding its action level is lead with a maximum detect of 0.204 mg/L versus an action level of 0.030 mg/L. The results of the human health screening risk assessment indicate that action to address contamination in soils and sediments in the outfalls is appropriate in order to protect human health.

The results of the screening ecological risk assessment indicate that several chemicals and compounds are present in sediment, surface water and soil associated with outfall watersheds at concentrations exceeding no action and "probable effect" screening values. These results indicate action to address contamination in sediments in Outfalls 001,008,010,011, and 015 is appropriate to protect ecological receptors.

During meetings in 2000 and 2001, the SWSC PCT identified the likely response activities required to contain/prevent/minimize the potential surface water discharge of contaminated sediment from PGDP. During development of these response actions, the SWSC PCT also considered recommendations of the CAB to the effect that the response actions developed be commensurate with the specific conditions that currently exist or that are likely to exist in the future at each outfall. The identification of likely response actions for each outfall was based on (1) the degree of contamination known to be present within the outfall watershed; (2) the potential for future activities within each watershed that could result in the potential release of contaminated sediment and; (3) the degree of uncertainty concerning the current or future levels of contamination that may be present within the watershed. Three likely response actions, Localized Controls, Integrated Controls, and Systems Controls, were identified.

The following alternatives are evaluated in this EE/CA:

- **Alternative 1 –** No Sediment Control Measures (All Outfalls);
- **Alternative 2 –** Localized Controls and Integrated Controls (Outfalls 010, 015, and the balance of Outfall 001);
- **Alternative 3 –** Localized Controls, Integrated Controls, and System Controls (New Outfall Ditch) (Outfalls 008 and 011); and
- **Alternative 4 –** Localized Controls, Integrated Controls, System Controls (New Outfall Ditch and Sediment Control Basin) (Outfalls 008 and 011).

The alternatives discussed in this EE/CA were developed using technologies representative of one or more of the response actions identified by the SWSC PCT. The proposed alternatives then were evaluated

against three criteria specified by the EPA (effectiveness, implementability, and cost) and against their ability to meet project specific Removal Action Objectives (RAOs).

The RAOs that have been established for the sediment control measures at Outfalls 001, *008,* 010,011, and 015 are as follows:

- Prevent discharge of contaminated sediments/soils from the outfalls to Bayou or Little Bayou Creek;
- Minimize sediment discharge from the outfalls;
- Develop the design of containment system, if a containment system is required, such that it is not incompatible with treatment of dissolved phase contaminants of concern; and
- Evaluate minimization **of** process water inflows to the sediment control system.

Based on the technology screening performed by the SWSC PCT and the evaluation performed for this EE/CA, Alternative **2,** Localized Controls and Integrated Controls, is the recommended removal action alternative for Outfalls 001, 010, and 015; Alternative 4, Localized Controls, Integrated Controls, and System Controls (New Outfall Ditch and Sediment Control Basin) is the recommended removal action alternative for Outfalls *008* and 011. These recommended sediment control measures would be maintained for as long as necessary to support ongoing active site remediation. For design purposes, it is assumed that the alternatives would have a 30-year life span. In addition, the sediment control measures implemented under each of these alternatives would be monitored, both quantitatively and qualitatively, to ensure that they are performing as expected. Details of the proposed monitoring plan will be presented in the **SWSC** RAWP. An RAWP will be prepared once public comments have been incorporated and the Action Memorandum has been approved by the EPA and the Commonwealth of Kentueky.

1. INTRODUCTION

The U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky have agreed that preventing off-site migration of contaminants is the highest site-wide priority for nonemergency cleanup activities at the Paducah Gaseous Diffusion Plant (PGDP), and that containment/prevention/minimization of potential surface water discharges of contaminants from PGDP is the highest priority for the Surface Water Operable Unit (SWOU). The SWOU is one of four operable units (OUs) at the PGDP being used to evaluate and implement remedial actions. The general scope and role of the SWOU is to focus on contaminated media that primarily contain or cause surface water and associated sediment contamination. The SWOU consists of 52 source units [i.e., solid waste management units (SWMUs)] and areas of concern (AOCs) that are being evaluated as part of the ongoing OU Remedial Investigation (RI)/Feasibility Study **(FS)** activities.

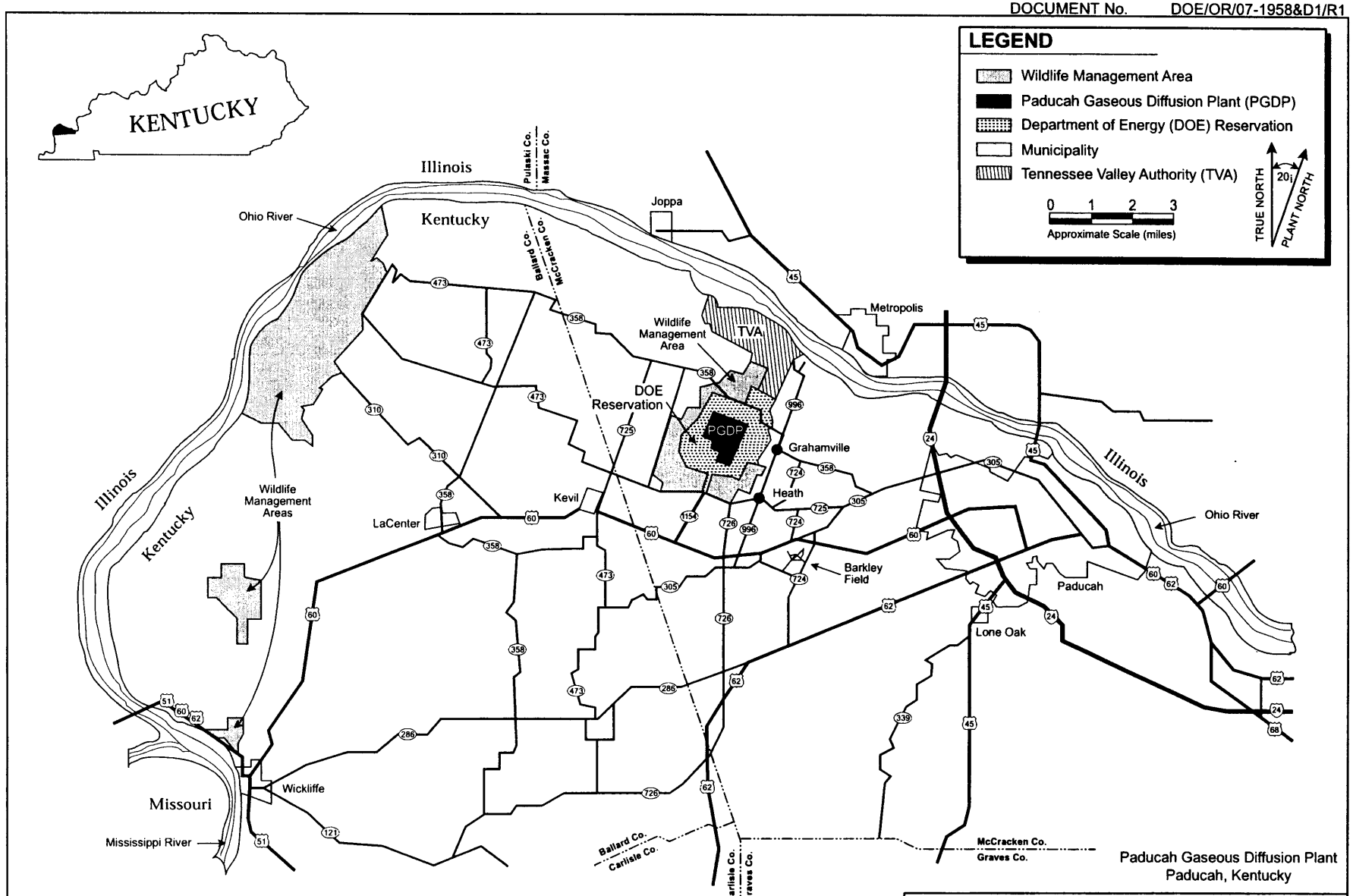
Surface water discharges from PGDP are released to Bayou and Little Bayou Creek via 17 outfall ditches. To prioritize the assessment and response activities required to contain/prevent/minimize the potential discharge of contaminated sediment from these outfalls, the Site-Wide Sediment Controls Project Core Team (SWSC PCT) consisting of representatives of DOE, EPA, and the Commonwealth of Kentucky met periodically during 2001 and 2002. During these meetings, the SWSC PCT considered recommendations made by the Citizens Advisory Board (CAB) to develop a site-wide surface water management strategy and conducted preliminary assessments of the 12 outfalls at PGDP designated as SWMUs. As a result of these assessments, Outfalls 008, 010, 011, 015, and that portion of Outfall 001 not addressed by storm water runoff and sediment control measures instigated as part of the Scrap Metal Disposition project (DOE 2001) [hereafter referred to as the balance of Outfall 001] were determined to need early action based on existing information.

DOE is proposing this Removal Action to address the potential for off-site migration of contaminated sediments from Outfalls 008, 010, 011, 015, and the balance of Outfall 001. This EE/CA was prepared in accordance with EPA's ***Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA*** (EPA 1993) and represents an early action to address site-wide sediment controls as part of the SWOU. Monitoring and further assessment of contamination in the SWOU will be performed prior to defining any final action for this OU. This early action is the last planned removal action for the SWOU prior to beginning remedial evaluation and cleanup.

1.1 SITE DESCRIPTION AND BACKGROUND

The PGDP, located in western Kentucky, is an active uranium enrichment facility owned by DOE. PGDP is located approximately 6.4 km (4 miles) south of the Ohio River and 16 km (10 miles) west of Paducah, Kentucky (Figure 1.1). The facility includes 302.8 hectares (ha) (748 fenced acres) within a DOE property of approximately 1,385 ha (3,423 acres).

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 site was shut down immediately after World War II and later became part of the West Kentucky Wildlife Management Area (WKWMA). 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.



U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig, 1.1. PGDP vicinity map; Paducah Gaseous Diffusion Plant - Paducah Kentucky.

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.

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 by 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.

DOE has undertaken projects to identify, investigate, and remediate, as necessary, all SWMUs and AOCs at PGDP. To facilitate the remediation process at PGDP and focus investigations on the most effective and efficient remedial actions, 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). Five OUs have been defined at PGDP: groundwater, surface water, soil, burial grounds, and comprehensive site wide (DOE 1998a). This removal action is included as part of the Surface Water OU.

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 32.18 km (20 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 eroded small valleys, which are about 6.09 m (20 ft) below the adjacent plain.

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 wetland area covering 66.8 ha (165 acres) exists 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 industnalized; however, the area surrounding the plant is mostly agricultural and open land, with some forested areas. The Tennessee Valley Authority's (TVA's) Shawnee Steam Plant, adjacent to the northeast border of the DOE property, 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 the 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, skeet shooting, and camping.

Total population within a 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 the greater Paducah area, based on the 2000 **U.S.** census, is approximately 30,000; 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]. The closest communities with public water supplies are Kevil, Kentucky, [about 4.83 km (3 miles) southwest] and Metropolis, Illinois, [about 6.44 km (4 miles) northeast, across the Ohio River].

1.1.3 Climate

The region in which PGDP is located has a humid-continental climate characterized by extremes of both temperature and precipitation. Table 1.1 presents a summary of average monthly precipitation and temperature for the region between 1984 and 1996 that is based on data generated at Barkley Regional Airport, located southeast of PGDP. The 13-year average monthly precipitation is 10 cm (3.96 inches), varying from an average of 6.57 cm (2.59 inches) in August to an average of 11.98 cm (4.72 inches) in February. The 13-year average monthly temperature is 26.38 C (57.9°F), varying from 1.38°C (34.5°F) in January to 14.38°C (79.5°F) in July.

Based on average wind speed and direction data recorded at Barkley Regional Airport for 1996, the average prevailing wind has a speed of 3.53 m/s (7.9 mph) and blows dominantly from the south or southwest. Generally, stronger winds are recorded when 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 Province (Figure 1.2). 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 1.3. A lithostratigraphic column of the Jackson Purchase Region is shown in Figure I.4.

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. 1992a). 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.

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.

Table 1.1. Thirteen-year average for precipitation and temperature, Barkley Regional Airport, Paducah, Kentucky

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual"
						Precipitation (inches)"							
1984	1.21	4.74	5.83	8.45	6.50	1.58	5.44	3.96	6.80	5.88	4.75	9.99	**65.13**
1985	1.82	3.70	3.67	6.85	4.13	4.85	**0.85**	5.89	9.23	7.26	4.29	1.34	**53.88**
1986	1.44	3.73	3.16	1.55	8.51	1.50	7.07	4.33	3.69	4.45	3.59	3.11	**46.13**
1987	0.99	3.93	1.93	2.30	1.43	4.03	2.58	1.31	2.80	1.58	4.29	9.19	**36.36**
1988	3.50	5.15	4.60	2.13	3.14	0.41	3.08	1.05	3.49	3.81	9.56	3.05	**42.97**
1989	5.31	13.33	5.36	2.55	2.33	9.20	7.07	1.80	2.64	3.48	2.59	1.78	**57.44**
1990	5.38	9.05	3.69	4.76	7.49	2.14	4.03	1.34	2.38	4.45	2.33	9.59	**56.63**
1991	3.77	4.07	3.55	3.81	4.29	1.47	3.23	2.42	3.25	3.57	2.17	3.84	**39.44**
1992	2.13	2.68	3.38	2.07	2.08	3.57	6.90	3.47	5.81	3.51	3.45	1.79	**40.84**
1993	3.79	3.99	2.99	5.14	2.59	5.51	0.56	2.89	6.00	3.82	6.45	3.57	**47.30**
1994	4.06	2.70	3.55	7.39	0.71	2.34	2.40	1.73	3.43	2.93	3.55	3.72	**38.51**
1995	4.20	3.26	1.78	4.34	5.68	4.19	3.28	3.52	1.47	2.30	2.72	1.89	**38.63**
1996	3.38	1.09	3.25	4.62	5.22	7.81	6.11	0.11	7.26	4.13	8.89	4.90	**56.77**
1997	2.62	5.32	7.42	5.03	7.95	6.59	2.78	2.86	2.4 1	2.92	2.73	4.26	**52.89**
1998	3.06	4.85	3.59	5.41	3.23	10.98	8.04	3.15	0.12	N/A	2.63	4.41	**N/A**
1999	8.03	2.54	3.09	6.6	3.71	8.97	0.28	0.54	0.66	3.93	0.9	4.04	**43.29**
2000	8.76	N/A	4.65	N/A	N/A	3.51	5.18	1.85	5.03	0.6	4.76	N/A	**N/A**
2001	2.34	4.26	2.64	1.7	4.42	3.82	5.54	6.12	3.9	6.36	12.52	N/A	**N/A**
POR= 18 years	3.66	4.61	3.79	4.39	4.32	4.58	4.13	2.69	3.91	3.82	4.57	4.40	**47.75**
						Average Temperature (°F)[b]							
1984	29.2	42.1	43.6	56.7	64.6	78.6	76.7	76.9	68.5	63.1	45.0	45.2	**57.5**
1985	23.9	32.0	51.3	60.9	66.8	73.3	78.4	74.8	68.8	62.4	52.5	31.3	**56.4**
1986	35.5	40.3	49.7	60.6	68.7	77.4	81.7	73.8	73.8	60.1	45.1	36.9	**58.6**
1987	33.5	40.9	50.2	57.4	73.0	78.2	79.5	79.8	71.6	53.4	50.9	41.1	**59.1**
1988	32.2	35.1	47.5	57.4	67.3	75.8	80.4	80.9	70.8	52.8	48.4	38.2	**57.2**
1989	41.4	32.8	48.1	57.3	64.6	73.6	78.3	77.7	69.3	59.9	48.6	27.1	***56.6***
1990	43.8	45.7	51.5	55.9	63.9	76.4	78.8	75.9	72.1	56.8	53.5	39.9	**59.5**
1991	34.2	41.9	51.4	62.3	72.5	78.0	80.9	78.4	71.1	61.1	45.4	41.9	**59.9**
1992	38.1	45.6	49.7	59.2	66.0	73.6	79.7	74.0	69.0	58.5	48.2	38.7	**58.4**
1993	38.3	36.9	46.6	55.9	67.3	76.5	84.3	78.7	67.3	56.1	45.6	38.5	**57.7**
1994	29.1	39.6	47.6	60.4	64.1	78.2	78.1	75.0	67.5	59.8	52.4	42.5	**57.9**
1995	37.0	37.5	51.4	59.7	67.5	75.3	79.5	80.8	66.9	58.9	42.0	36.6	**57.8**
1996	32.7	37.9	41.0	53.9	69.7	75.3	75.9	76.6	67.8	58.3	43.0	40.2	**56.0**
1997	31.9	42.5	50.1	52.5	62.1	73.1	78.8	75.2	68.8	57.8	42.5	37	**56.0**
1998	40.5	44.1	47.4	56.5	71.1	76.4	78.7	77	74.9	N/A	50.6	40.4	**59.8**
1999	37.7	43.7	43.7	60.1	66	75.6	81.6	76.4	69.4	59.1	53.2	40.4	**58.9**
2000	36.3	N/A	50.3	N/A	N/A	74.8	77.2	78.6	67.3	60.5	44.5	N/A	**61.2**
2001	32.3	39.4	42	61	68	73	78	77	67.8	57.6	50.8	N/A	**58.8**
POR= 18 years	**34.9**	**39.9**	**47.9**	**58.1**	**67.3**	**75.7**	**79.3**	**77.1**	**69.6**	**58.6**	**47.9**	**38.5**	**57.9**

[a] To convert measurement in inches to centimeters, multiply value by **2.54.**
[b] To convert temperature in °F to °C, subtract **32** from the value, then multiply the result by 5/9.
[c] For years which have missing monthly average precipitation data, annual precipitation sums not calculated.

Fig. 1.2. Physiographic provinces of the Commonwealth of Kentucky.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

JACOBS Bechtel Jacobs Company LLC
BECHTEL JACOBS COMPANY LLC
Oak Ridge, Tennessee ● Paducah, Kentucky ● Portsmouth, Ohio
US GOVERNMENT CONTRACT DE-AC-05-98OR22700

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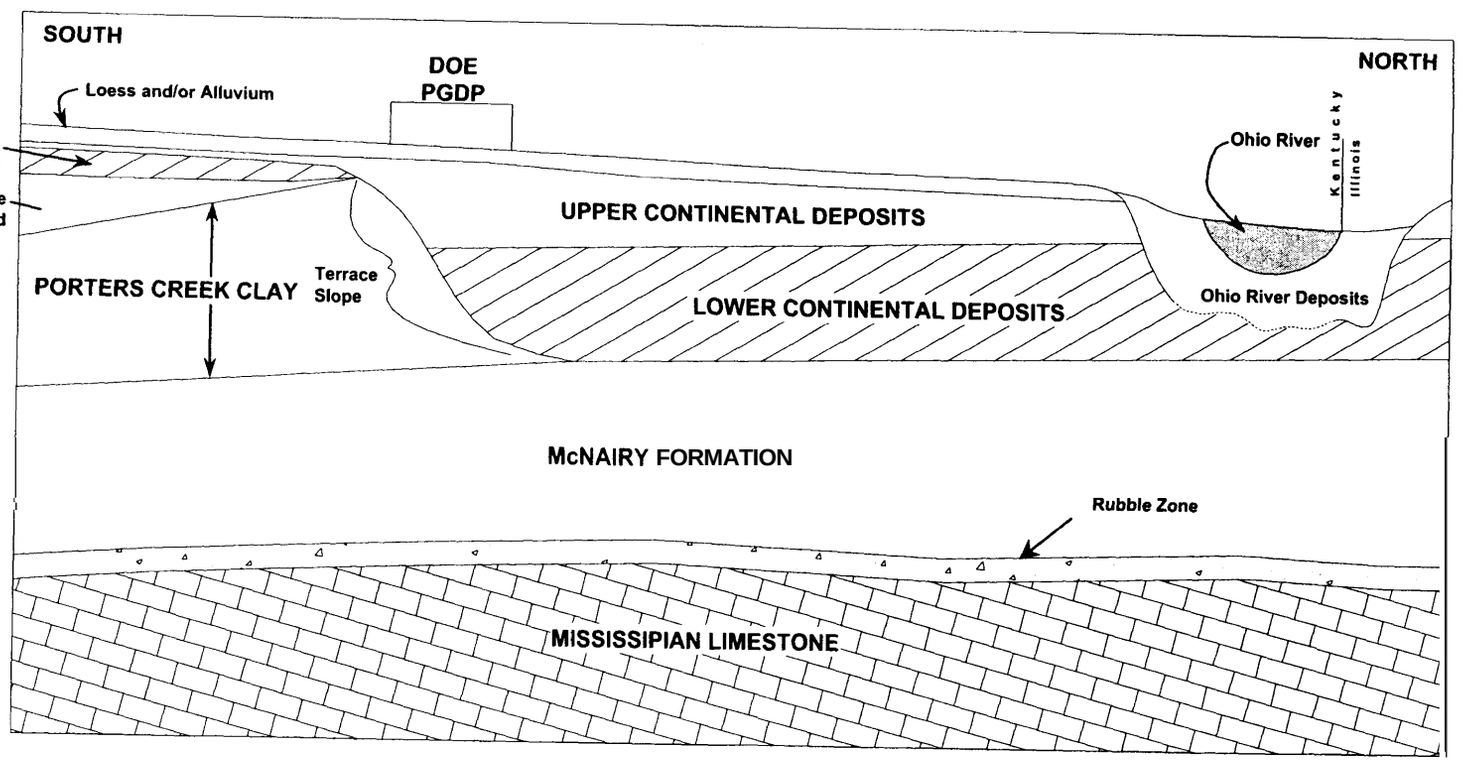
FIGURE No. 0992-1-2
DATE 05-23-01



NOT TO SCALE

Fig. 1.3. Generalized geologic cross-section for the PGDP.

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Oak Ridge, Tennessee 37831

SYSTEM	SERIES	FORMATION	THICKNESS (IN FEET)	DESCRIPTION	HYDROGEOLOGIC SYSTEMS
QUATERNARY	PLEISTOCENE AND RECENT	ALLUVIUM	0-40	Brown or gray sand and silty clay or claycy silt with streaks of sand.	Upper Continental Recharge System (UCRS)
	PLEISTOCENE	LOESS	0-43	Brown or yellowish-brown to tan unstratified silty clay.	
	PLEISTOCENE	CONTINENTAL DEPOSITS	3-121	Upper Continental Deposits (Clay Facies) - mottled gray and yellowish brown to brown clayey silt and silty clay, some very fine sand, trace of gravel. Often micaceous.	
TERTIARY	PLIOCENE-MIOCENE (?)			Lower Continental Deposits (Gravel Facies) - reddish-brown claycy, silty and sandy chert gravel and beds of gray sand.	Regional Gravel Aquifer
	EOCENE	JACKSON, CLAIBORNE, AND WILCOX FORMATIONS	0-200+	Red, brown or white fine to coarse grained sand. Beds of white to dark gray clay are distributed at random.	McNairy Flow System
			0-100+	White to gray sandy clay, clay conglomerates and boulders, scattered clay lenses and lenses of coarse red sand. Black to dark gray lignitic clay, silt or fine grained sand.	
	PALEOCENE	PORTERS CREEK CLAY	0-200	Dark gray, slightly to very micaceous clay. Fine grained claycy sand, commonly glauconitic in the upper part. Glauconitic sand and clay at the base.	
		CLAYTON FORMATION	Indetermined	Lithologically similar to underlying McNairy Formation.	
UPPER CRETACEOUS		McNAIRY FORMATION	200-300	Grayish-white to dark gray micaceous clay, often silty, interbedded with light gray to yellowish-brown very fine to medium grained sand with lignite and pyrite. The upper part is interbedded clay and sand, and the lower part is sand.	
		TUSCALOOSA FORMATION	Undetermined	White, well rounded or broken chert gravel with clay.	
MISSISSIPPIAN		MISSISSIPPIAN CARBONATES	500+	Dark gray limestone and interbedded chert, some shale.	

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Fig. 1.4. Lithostratigraphic column of the Jackson Purchase Region.

FIGURE No. 1_4
DATE 05-23-01

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.

While contaminated media that primarily contains or causes surface water and associated sediment contamination is dealt with under the SWOU, contaminated soils at PGDP are addressed under the Soils Operable Unit (SOU). The SOU focuses on the evaluation and remediation of soils that contain existing contamination and/or may act as a source of contamination to groundwater.

1.1.5 Hydrogeology

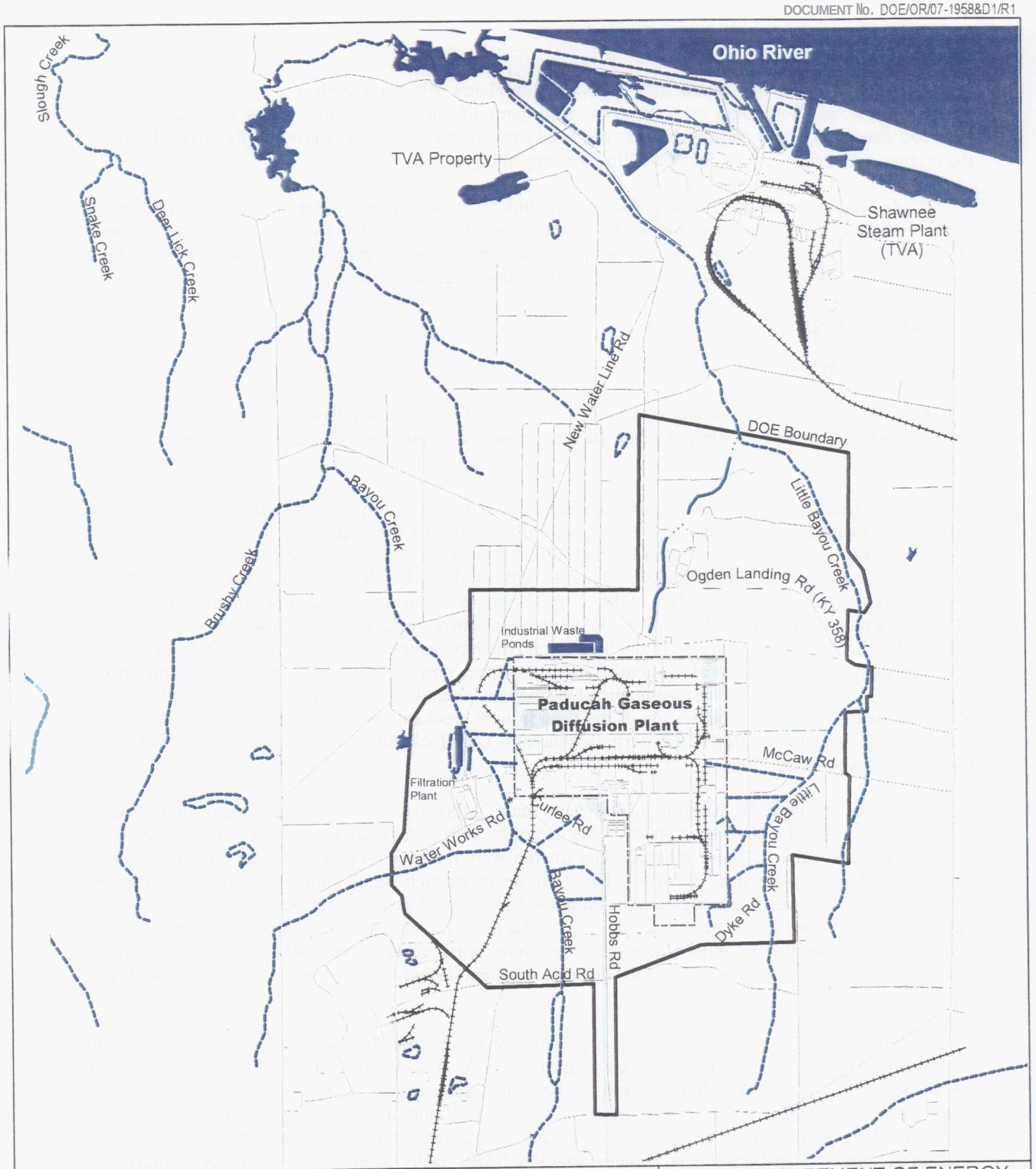
1.1.5.1 Surface Water

PGDP is located in the western portion of the Ohio River drainage basin. The plant is within the drainage areas of Bayou Creek and Little Bayou Creek and is situated on the divide between the two creeks (Figure 1.5).

Bayou Creek, a perennial stream with a drainage area of approximately 48 km^2 (18.6 **mi'),** extends along the western boundary of the plant and flows generally northward from approximately 4 km (2.5 miles) south of the plant site to the Ohio River. Little Bayou Creek, a perennial stream at points downgradient of its confluence with Outfall 010 at PGDP, originates within WKWMA, flows northward to the Ohio River, and extends along the eastern boundary of the plant. The approximate drainage area of Little Bayou Creek is 22' km (8.5 mi') (CH2M Hill 1992). 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 creeks discharge into the Ohio River. The drainage areas for both creeks are generally rural; however, they receive surface runoff from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and the TVA Shawnee Steam Plant. A major portion of the flow in both creeks north of PGDP is effluent water from the plant, discharged through KPDES-permitted outfalls. Deer Lick, Snake Creek, and Slough Creek drain the area northwest of the PGDP.

PGDP was engineered to promote surface water runoff rather than groundwater infiltration, to the extent possible. As illustrated in Figure 1.6, storm water and effluent from the plant flow into a series of man-made ditches and storm sewers. These internal plant ditches were trenched when PGDP was built and became operational when the plant opened in 1951. The storm sewer for each outfall consists of a network of buried piping that collects surface drainage **and** building roof and floor drainage. These ditches and stonn sewers direct flow off of plant property via outfalls that discharge to the creeks. The plant ditches generally are considered to be located in areas where the local groundwater table is below the bottoms of the ditch channels. Therefore, the ditches probably function as influent (losing) streams most of the time, resulting in some recharge to the subsurface.

The plant has 17 outfalls, which have a combined average daily flow of approximately 18.5 million liters per day (mlpd) [4.9 million gal per day (mgpd)] (Clausen et al. 1992b). The locations of these outfalls are shown on Figure 1.6. A KPDES permit regulates the water quality at each outfall through required regular testing at established monitoring stations. Of the 17 total outfalls, 14 are open and maintained under the current KPDES permits. The remaining 3 outfalls are inactive. Outfalls 002, 004, 006, 008, 009, 010 through 013, and 016 are permitted to and monitored by USEC. DOE maintains the permit for Outfalls 001, 015, 017, and 019. Each permitted outfall is monitored at varying frequencies of once per week to once per quarter, dependent upon the parameter being tested. The monitored effluent characteristics and discharge limits vary according to outfall, with some characteristics being "report only" without designated limit. Effluent characteristics monitored under the KPDES permits include the following: discharge temperature,



LEGEND:
ROAD
RAILROAD
DOE BOUNDARY
PGDP BOUNDARY
STREAM
SURFACE WATER BODY

1000 0 1000 2000 Feet

TRUE NORTH 20 PLANT NORTH

U.S. DEPARTMENT OF ENERGY
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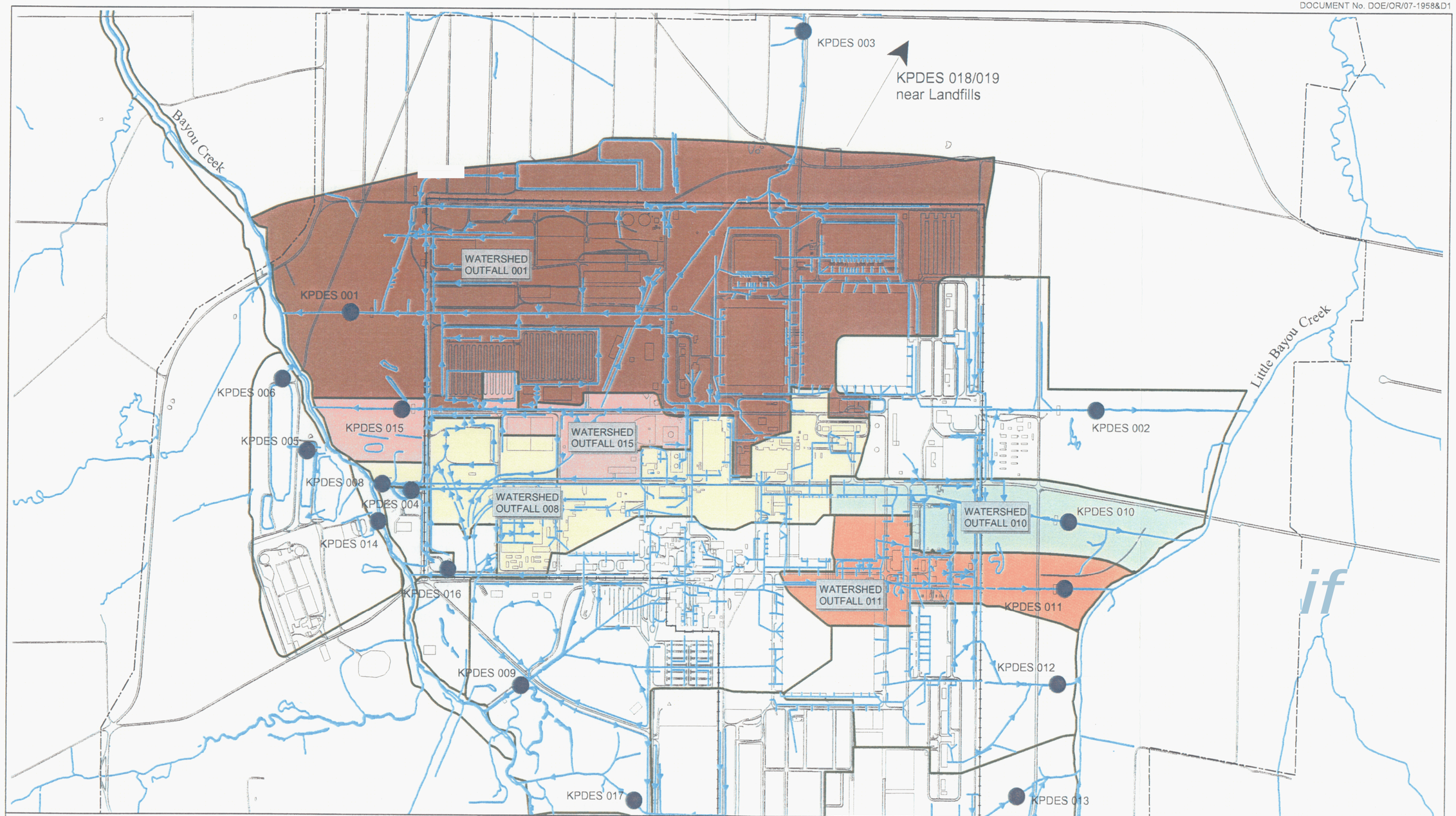
Fig. 1.5. Surface water features in the vicinity of the PGDP.

Figure No. 0992-1_5.apr
DATE 01-15-02



LEGEND
- Road
- Stream
- PGDP Boundary
- DOE Boundary
- General Flow Direction
- KPDES Outfall
- Watershed Boundary

NOTE: Shaded watersheds are addressed by this Site-Wide Sediment Controls Removal Action.

500 0 500 1000 Feet

TRUE NORTH 28 PLANT NORTH

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FIGURE No. c5bc90001sk245.apr
DATE 01-18-02

Fig. 1.6. KPDES Outfall locations and generalized surface water flow patterns at PGDP.

flow, pH, phosphorous content, total suspended solids, uranium, tnchloroethene (TCE), technetium-99 (^{99}Tc), and polychlorinated biphenyls (PCBs). KPDES permit information for PGDP outfalls, such as monitoring and sampling results, is available at the Environmental Information Center in the Barkley Centre, Paducah, Kentucky.

1.1.5.2 Groundwater

Local groundwater flow near PGDP occurs in the unconsolidated sediments of the Cretaceous McNairy Formation, Eocene Sands, Pliocene Terrace Gravel, Pleistocene Lower Continental Deposits (LCD), and Upper Continental Deposits (UCD). Terms used to describe the hydrogeologic flow systems that generally correspond to these lithostratigraphic units are the McNairy Flow System, Eocene Sands, Pliocene Terrace Gravel, Regional Gravel Aquifer (RGA), and Upper continental Recharge System (UCRS).

The RGA is the dominant aquifer within the local flow system. The unit is a Pleistocene gravel deposit of the LCD overlying an erosional surface. The RGA is found throughout the plant area and to the north, but pinches out to the south, southeast, and southwest along the slope of the Porters Creek Terrace. Regionally, the RGA includes the Holocene-aged alluvium found adjacent to the Ohio River.

Potential sources of contamination to groundwater at PGDP include the losing reaches of the ditches and streams within and around the plant. Remedial or removal actions performed under the SWOU will reduce the amount of contamination available to leach to groundwater. Conversely, the lower reaches of the streams in the vicinity of PGDP receive potentially contaminated groundwater discharge. The evaluation and implementation of remedial actions for the sources of groundwater contamination at PGDP will be addressed under the Groundwater Operable Unit (GWOU).

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). Information on small mammal populations at PGDP are available in the ***Drum Mountain Small Mammal Sampling, March 2000, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (CDM ***2000)*** and the ***Scrap Yards Small Mammals Sampling Project Report, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (CDM 2001). A recent study has confirmed the presence of a T&E species in the vicinity of the PGDP (KDFWR 2000).

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 communities range from an oak and hickory forest in areas that have been undisturbed to managed fencerows and agricultural lands in the more developed areas. The main crops in the PGDP area include soybean, corn, tobacco, and various grain crops such as millet.

Old-field grasslands constitute approximately **809.7** ha (2,000 acres) of the WKWMA. Much of this herbaceous community is dominated by members of the ***Coinpositae*** family and various grasses. Woody species, such as red maple, also are occasionally present. Some of this area includes remnant prairie, as indicated by the presence of eastern gama and Indian grasses. The shrub community represents a more diverse habitat, including both herbaceous and woody species. Within WKWMA, approximately **324** ha (800 acres) consist of scrub-shrub habitat. Dominant trees include cherry, persimmon, sumac, young hickory,

and three species of oak, as well as scattered growths of sweetgum and hackberry. Forest and shrub tracts alternate with fencerows and transitional edge habitats along roads and power transmission-line corridors. Elm, locust, oak, and maple, with an understory of sumac, honeysuckle, blackberry, poison ivy, and grape, dominate fencerow communities. Herbaceous growth in these areas includes clover, plantain, and numerous grasses.

Mice, rabbits, and a variety of other small mammals frequent open herbaceous areas. Birds identified in the area include red-winged blackbirds, quail, sparrows, and predators such as hawks and owls. In transitional areas, including fencerows, low shrub, and young forests, a variety of wildlife is present, including opossum, vole, mole, raccoon, and deer. Birds typically found in the transitional areas include red-winged blackbirds, shrikes, mourning doves, quail, turkeys, cardinals, and meadowlarks. Several groups of coyotes also reside in areas around PGDP. In addition to the larger mammals, mature forests contain squirrels, songbirds, and great homed owls. Muskrat and beaver are found in the aquatic habitats of the PGDP area. Many species of waterfowl also use these areas, including wood ducks, geese, herons, and various other migratory birds. Various reptiles, amphibians, and terrestrial invertebrates (e.g., insects and spiders) are present in all areas. Domestic livestock is abundant in surrounding farmlands.

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 North-South Diversion Ditch (NSDD); a marsh located at the confluence of Bayou Creek and Little Bayou Creek; and other smaller drainage areas. Perennial aquatic habitat is present in Bayou Creek, in that portion of Little Bayou Creek downgradient of Outfall 010 (a continuous flow outfall), within the Outfall 010 ditch downgradient of the discharge point from the C-617 Treatment Lagoon, and within the ditches of Outfalls 001 and 008 (also continuous flow outfalls). Due to the intermittent nature of Little Bayou Creek, only limited areas of aquatic habitat are available along those portions upgradient of Outfall 010.

The dominant taxa in the surface water in the vicinity of PGDP include several species of sunfish, especially bluegill and green sunfish, as well as bass and catfish. Bluegill, green and longear sunfish, and stonerollers dominate shallow streams characteristic of the two area creeks.

1.1.6.3 Wetlands and Floodplains

Wetlands were identified during an environmental investigation of 4,745 ha (11,719 acres) surrounding PGDP that was conducted by the U.S. Army Corps of Engineers (COE) in 1994 (COE 1994b). In that investigation, 1,083 separate wetland areas were identified and grouped into 16 vegetation cover types. Wetlands inside the plant security fence are confined to portions of drainage ditches traversing the site (CDM 1994). At PGDP, three bodies of water cause most area flooding: the Ohio River, Bayou Creek, and Little Bayou Creek. A floodplain analysis performed by COE (1994c) indicated 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 indicated that ditches within the plant area can contain the expected 100- and 500-year discharges.

1.1.6.4 T&E Species

Potential habitat for federally listed T&E species was evaluated for the area surrounding the PGDP during the 1994 COE environmental investigation of the PGDP (COE 1994) and inside the fence of the PGDP during the 1994 investigation of sensitive resources at the PGDP (CDM Federal 1994). No T&E species or potential habitat for any T&E species was observed during the inside-the-fence investigation. In 1999, five Indiana bats (*Myotis sodalis*) were captured near the lower downstream reaches of Bayou Creek (KDFWR 2000).

Ten federally-listed, proposed, or candidate species have been identified as potentially occurring at or near the PGDP (Table 1.2). No critical habitat for any of these species has been designated anywhere in the study area (BJC **2000).** None of the species has been reported as sighted on the DOE Property. Potential summer habitat exists on the DOE Property for the Indiana bat, and Indiana bats have been captured in the vicinity (KDFWR 2000). The Indiana bat is likely to forage in the vicinity of the outfall ditches, particularly near the confluences of the ditches with Bayou and Little Bayou Creeks.

Table 1.2. Federally listed, proposed, and candidate species potentially occurring within PGDP area

Common name	Scientific name	Endangered Species Act status
Indiana bat	***Myotis sodalis***	Listed Endangered
Interior least tern	***Sterna antillarum athalassos***	Listed Endangered
Pink mucket	***Lampsilis abrupta***	Listed Endangered
Ring pink	***Obovaria retusa***	Listed Endangered
Orange-footed pearly mussel	***Plethobasus cooperianus***	Listed Endangered
Fat pocketbook	***Potamilus capax***	Listed Endangered
Tubercled-blossom pearly mussel	***Epioblasma torulosa torulosa***	Listed Endangered
Bald eagle	***Haliaeetus leucocephalus***	Listed Endangered
Sturgeon chub	***Macrhybopsis gelida***	Candidate
Sicklefin chub	***Macrhybopsis meeki***	Candidate

1.2 SITE-WIDE SEDIMENT CONTROLS PROJECT CORE TEAM STRATEGY

DOE, EPA, and the Commonwealth of Kentucky have agreed that preventing off-site migration of contaminants is the highest site-wide priority for nonemergency cleanup activities at PGDP, and that containment/prevention/minimization of potential surface water discharges of contaminants from PGDP is the highest priority for the SWOU. In early 2000, DOE, EPA, and the Commonwealth of Kentucky agreed to establish a technical working group known as the SWSC PCT. This team consists of representatives from DOE, EPA, and the Commonwealth and was established with the intent of providing a mechanism to build consensus among the parties of the PGDP **FFA** in an effort to expedite the scoping, planning, and development process for site characterization and removal/remediation activities (including the development, review, and approval of CERCLA decision documents). The SWSC PCT process effectively meets the intent of Condition XX (E) of the **FFA,** "MEETING OF PROJECT MANAGERS," and SWSC PCT discussions are recorded formally in meeting minutes. Any consensus reached by the SWSC PCT is preliminary and subject to requirements of CERCLA and the FFA, including, but not limited to, public participation requirements.

The SWSC PCT met periodically during 2000 and 2001 to prioritize the assessment and response activities required to contain/prevent/minimize the surface water potential discharge of contaminated sediment from PGDP and to consider recommendations made by the CAB to develop a site-wide surface water management strategy. During these meetings the SWSC PCT conducted preliminary assessments of the 12 outfalls at PGDP designated as SWMUs or AOCs and identified ten conditions that could exist at each SWMU. Based on the results of these assessments, each outfall was "binned" into one of the following three categories:

- Category 1 – requires action based on existing information;
- Category 2 – requires further assessment; or
- Category **3** – does not require action based on existing information.

The criteria used to determine the category into which each of the 12 outfalls should be binned are provided below.

Category 1

For an outfall to be binned into Category 1 (requires action), the SWSC PCT determined that one or more of the following conditions would have to be present:

- Condition 1 – Existing sediment contamination in or below an outfall at concentrations that exceed human health risk levels of 1×10^{-4} for a child recreator or ecological risk levels of a hazard index (HI) of 3;

- Condition 2 – Existing surface water discharge of sediment contamination or dissolved phase contamination through an outfall at contaminant concentrations that exceed human health risk levels of 1×10^{-4} for a child recreator or ecological risk levels of an HI of 3; or

- Condition 3 – Planned near-term (i.e., within two years) remediation of upgradient SWMUs with disturbance of contaminated surface soil that could result in the future potential for surface water discharge of sediment contamination or dissolved phase contamination through an outfall at concentrations that exceed human health risk levels of 1×10^{-4} for a child recreator or ecological risk levels of an HI of 3.

Category 2

Binning of an outfall into Category 2 (requires further assessment) would be appropriate if one or more of the following conditions were present:

- Condition 4 – Existing sediment contamination in or below an outfall at concentrations within the human health risk level range of 1×10^{-4} to 1×10^{-6} for a child recreator or within the ecological risk level range of an HI of 3 to an HI of 0.1;

- Condition 5 – Existing surface water discharge of sediment contamination or dissolved phase contamination through an outfall at contaminant concentrations within the human health risk level range of 1×10^{-4} to 1×10^{-6} for a child recreator or within the ecological risk level range of an HI of 3 to an HI of 0.1;

- Condition 6 – Long-term (i.e., within some time greater than two years) remediation of upgradient SWMUs is planned, or

- Condition 7 – Sufficient information currently does not exist to determine **risk** to human or ecological receptors.

Category 3

For an outfall to be placed into Category 3 (does not require action), the SWSC PCT determined that all of the following conditions would have to exist:

- Condition 8 – Sufficient information exists to indicate that no human or ecological risk or dose concerns exist;

- Condition **9** – There are no exceedances of regulatory criteria; and

- Condition 10 – No remediation of upgradient SWMUs is planned.

During this assessment the contamination levels present in the watershed were compared to risk-based values calculated using either a target cancer risk value of 1×10^{-4} or a target HI value of 3. The cancer risk value is the probability of the development of cancer upon exposure to a carcinogen. **A** cancer risk value of 1×10^{-4} indicates that an individual has a 1 in 10,000 chance of developing cancer upon exposure to the carcinogen. The HI is a measure of the potential for development of a systemic toxic effect within an individual upon exposure to a chemical or compound. **A** HI value below 1 indicates that the development of a toxic effect is unlikely. **A** value greater than 1 indicates that a toxic effect may occur.

A risk value of 1×10^{-4} was selected by the SWSC PCT as the trigger for inclusion of an outfall into Category 1 (an action is required) because **EPA** guidance states that risks greater than 1×10^{-4} must be remediated. **A** child recreator was chosen as the risk receptor because a child represents the most susceptible risk receptor for contaminated sediments transported offsite. In addition, the highest detection of each contaminant was always used in the comparison with human health risk action levels, even if this concentration of a particular contaminant was significantly higher than all other occurrences. The selection of these risk levels and the conservative approach of always using the highest contaminant concentration satisfies the CAB's request for the SWSC PCT to establish human health and ecological risk-based, fair, just, and equal numerical values for potential contaminants in surface water discharges.

Based on consideration of these criteria, the SWSC PCT binned five outfalls (008, 010, 011, 015, and the balance of 001) into Category 1 and seven outfalls (002, 004, 009, 012, 013, 014, and 017) were binned into Category **2.** Based on their review of the available data, the **SWSC** PCT determined that insufficient information existed to ascertain whether or not ecological risk or dose concerns existed for any of the outfalls at PGDP. The **SWSC** PCT further determined that ecological risk assessments would be required before agreement could be reached on a no-action decision for any outfall. Consequently, no outfalls were binned into Category 3. Further information on this preliminary data screening and assessment conducted by the SWSC PCT for the five outfalls designated as requiring current action (i.e., Category 1 outfalls) is provided in Section 1.5. Detailed information on the screening risk assessment conducted for this removal action is presented in Section 1.6, Streamlined Risk Evaluation.

1.3 ANALYTICAL DATA

As the initial step in their assessment process, the SWSC PCT assembled all existing surface water and sediment/soil data from historical investigations of the PGDP outfalls and the SWMUs located within the outfall watersheds. These raw datasets were reviewed and all subsurface soil data collected from depths greater than 1 ft below ground surface (bgs) were removed so that the assessment of soil contamination would focus only on those sediments and surface soils reasonably expected to be available for transport by surface water flow. The resulting datasets were designated as "binning packages" **(SAIC** 2001). This analytical data can be found in the Administrative Record located at the DOE Environmental Information Center, Paducah, KY.

The following sections provide a summary of the findings of the binning process conducted by the SWSC PCT. Results of the risk-based screening conducted on the above referenced binning packages for Outfalls 008, 010, 011, 015, and the balance of Outfall 001 are presented in Section 1.6.

Comparisons of the data in the binning packages for Outfalls 001, 008, 010, 011, and 015 to provisional soil background concentrations identified several inorganic chemicals and radionuclides that were above background. (Provisional background concentrations do not exist for organic compounds.) Contaminants found at concentrations 10 times their provisional background value are shown in Table 1.3.

Table 1.3. Inorganic chemicals (mg/kg) and radionuclides (pCi/g) found at concentrations above provisional background in outfall soils and sediments

Contaminant	Frequency above background[a]	Maximum Detected Value[b]	Provisional Background Value[c]
		Outfall 001	
Antimony	6/25	2.90	0.21
Arsenic	13/37	130	12
Beryllium	13/25	13.7	0.67
Cadmium	15/33	6.53	0.21
Selenium	9/37	12.5	0.8
Silver	10/37	83.3	2.3
Thallium	9/29	4.50	0.21
Uranium	53/66	6,500	4.9
Cesium-137	6/32	51.0	0.49
Neptunium-237	17/47	63.0	0.1
Plutonium-239	25/40	240	0.025
Technetium-99	26/59	3,900	2.5
Thorium-230	24/45	1,300	1.5
Uranium-234	26/34	150	2.5
Uranium-235	20/33	12.0	0.14
Uranium-238	31/34	314	1.2
		Outfall 008	
Antimony	20/82	4.00	0.21
Beryllium	21/87	15.4	0.67
Cadmium	27/99	6.50	0.21
Calcium	6/87	277,000	200,000
Chromium	35/99	258	16
Copper	18/87	281	19
Mercury	14/99	7.70	0.2
Selenium	4/99	25.0	0.8
Silver	2/99	42.5	2.3
Neptunium-237	11/40	12.2	0.1
Plutonium-239	17/29	13.0	0.025
Technetium-99	31/76	640	2.5
Thorium-230	10/38	188	1.5
Uranium-234	20/66	76.0	2.5
Uranium-235	21/60	4.00	0.14
Uranium-238	41/66	120	1.2
		Outfall 010	
Cadmium	12/33	2.73	0.21
Neptunium-237	¼	12.8	0.1
Technetium-99	4/30	2,650	2.5
Uranium-238	21/22	51.7	1.2
		Outfall 011	
Beryllium	6/18	7.40	0.67
Cadmium	3/18	2.30	0.21
Chromium	12/18	371	16
Nickel	5/18	382	21
Uranium	12/12	1,030	4.9
Technetium-99	6/25	105	2.5
Uranium-234	10/11	379	2.5
Uranium-235	5/34	49.0	0.14
Uranium-238	11/11	2,740	1.2
		Outfall 015	
Beryllium	7/9	21.2	0.67
Cadmium	6/9	3.60	0.21
Cesium-137	¼	52.3	0.49
Neptunium-237	1/9	12.2	0.1
Plutonium-239	6/6	2.50	0.025
Thorium-230	5/9	188	1.5
Uranium-238	7/8	14.0	1.2

[a] Number of times the contaminant was detected above its provisional background concentration in surface soil over number of samples in which a analyses for the contaminant was performed.

[b] Maximum detected concentration reported in binning package (SAIC 2001).

[c] Provisional background concentration for surface soil taken from Table A-12 in the December 2000 draft of Methods for Conducting Human Health Risk Assessments and Risk Evaluations *at* the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE 2000a).

1.4 PREVIOUS INVESTIGATIONS AND RESPONSE ACTIONS

Outfalls 001, 008 and 015 lie on the west side of the PGDP and Outfalls 010 and 011 are located on the east side (Figure 1.6). Each Outfall receives surface water runoff and wastewater from various permitted sources within PGDP.

Storm water runoff and wastewater from the PGDP leave the site through the outfall ditches, draining either east to Little Bayou Creek (Outfall 010 and 011) or west to Bayou Creek (Outfalls 001, 008,015). The outfalls are significant contributors **of** surface inflow to the two creeks and represent an important route of potential contaminant transport within the environment.

1.4.1 West Side Outfalls

The West Side Outfalls discharge into Bayou Creek. The 1998 Clean Water Act, Section **303** (d) list includes Bayou Creek as a first priority impaired waterway because it does not support its use designation for Aquatic Life. Currently the Commonwealth of Kentucky Division of Water is considering posting Bayou Creek for PCB contamination and also is considering the creation of a PCB Total Maximum Daily Load (TMDL) limit of 0 parts per billion (ppb) to create conditions suitable for the use designation of Warm Water Aquatic Habitat. Should a PCB TMDL be designated for Bayou Creek, it would be expressed as a goal and would not be equivalent to a KPDES permitted limit. If monitoring in accordance with the KPDES permit indicates that exceedances of the designated TMDL are occurring, these exceedances will be evaluated and corrective responses will be undertaken as a CERCLA action separate from this removal action.

1.4.1.1 Outfall 001 (balance)

Outfall 001 has the largest watershed at the PGDP and receives drainage from an area of about 82.26 ha (203 acres), including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 001 is approximately 6,224 m (20,420 ft) in length, unlined, and approximately 0.15 to 3.6 m (0.5 to 12 ft) deep. The reported monthly average flow through Outfall 001 into Bayou Creek is 2.79 mgpd. Outfall 001 became the responsibility of DOE under the KPDES permit in 1997. **A** conceptual model of the outfall is presented in Figure 1.7.

Between 1974 and 1983 numerous uranium enrichment process upgrade programs were conducted at PGDP. These programs included the dismantlement, removal, and on-site storage of contaminated equipment, cell components, and scrap metal from the cascade facilities. Much of the scrap metal was stored in scrap yards located in the northwestern portion [approximately 20.4 ha (50.5 acres)] of the Outfall 001 watershed. PGDP site investigations conducted in 1991 and 1992 documented contamination in the vicinity of the scrap yards and a Public Health and Ecological Assessment conducted in 1992 concluded that the scrap yards might contribute to the off-site migration of uranium. ***An*** interim action consisting of the installation of silt barriers was performed in 1993 to reduce the potential for uranium-contaminated silt and sediment migration from the scrap yards.

Removal and final disposition of the scrap metal located in the northwest portion of Outfall 001 is addressed in the *Engineering Evaluation/Cost Analysis **for** Scrap Metal Disposition **at** the Paducah Gaseous Diffusion Plant,* Paducah, Kentucky (DOE 2001). While the soil located beneath the scrap metal piles will not be excavated or removed, the potential for soil disturbance with associated sediment transport will exist during performance of scrap metal removal. The Scrap Metal Removal Action includes sediment controls measures that will contain both the sediment that may be mobilized by disturbance of the scrap metal yards and sediment derived from the general watershed within the northwestern most 20.4 ha (50.5 acres) **of** Outfall 001. The sediment control measures discussed in this document will provide containment of sediment mobilized from the balance **of** Outfall 001 [i.e., the remaining 61.7 ha (152.5 acres)].

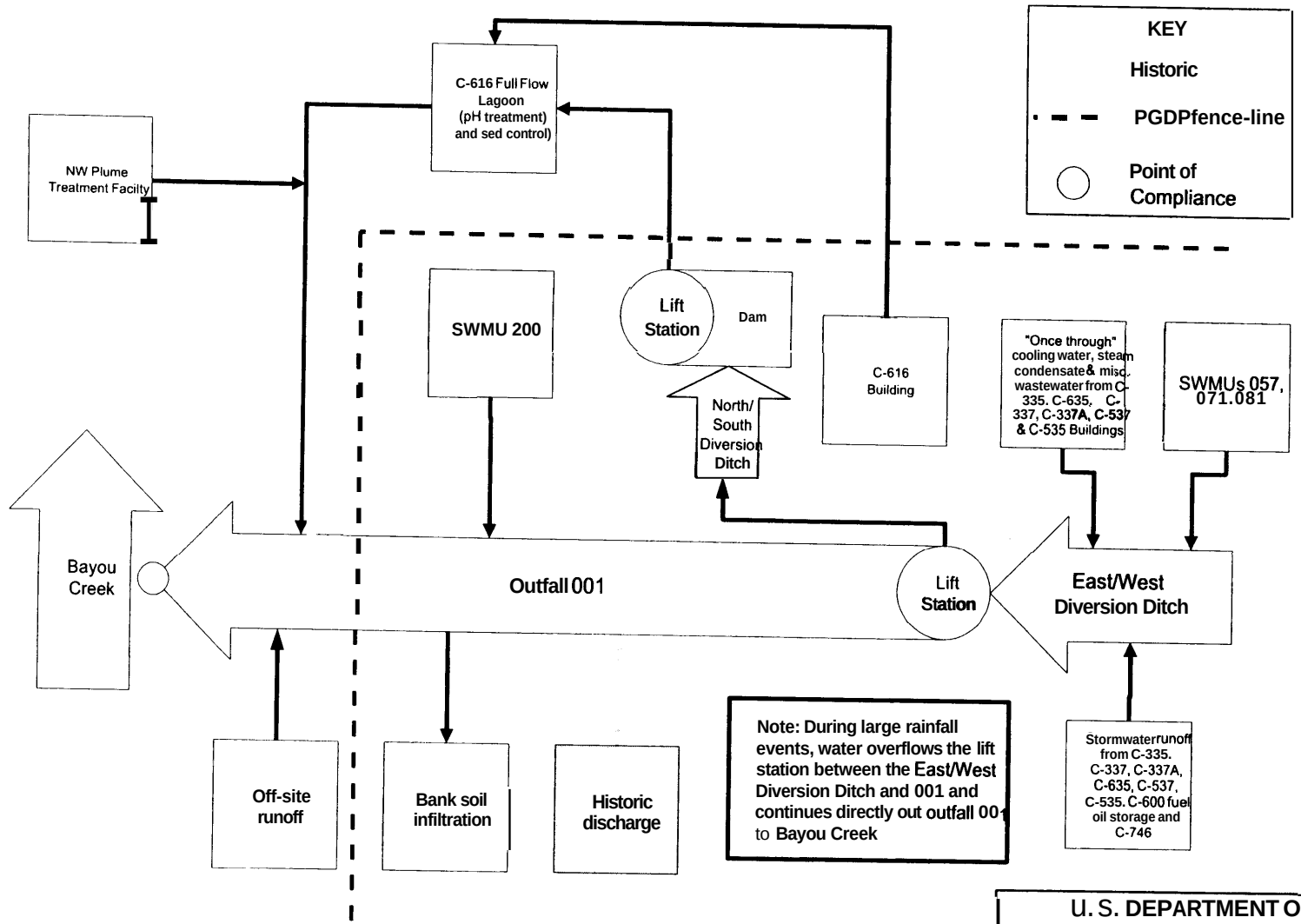

Fig. 1.7. Conceptual model of Outfall 001.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O Box2502
Oak Ridge, Tennessee 37831

FIGURE No. C5AC90001SK250.ppt
DATE 01-18-02

The balance of Outfall 001 receives wastewater and surface water runoff from multiple sources in the northwest portion of the plant. Facilities that drain into this portion of Outfall 001 include: the C-335 Process Building; the C-337 Process Building; the C-337-A Vaporizer (SWMU 71); and the C-400 Cleaning Building; C-410 Feed Plant and Appurtenant Structures (C-411 Cell Maintenance Building, C-415 Feed Plant Storage Building, and the C-420 Greensalt Plant); the C-600 Steam Plant and Supporting Facilities. Runoff from the C-400, C-410, and C-415 areas drain to the NSDD, which is routed through the C-616 Lagoon for treatment prior to discharge to Outfall 001. The C-335 and C-337 Process Buildings drain to Outfall 001 via the storm sewer system.

Potential sources of contamination at the C-410 Feed Plant include uranium tetrafluoride, (UF_4) uranium hexafluoride (UF_6), hydrofluoric acid (HF), mercury, and equipment oils. The facility has evidence of roof leaks and open floor drains; therefore, it is possible that all of the contaminants have been discharged to the storm drains. The facility also contains potentially contaminated PCB scrap metal. According to the Phase II Site Investigation **(SI),** the soil around the C-410-B sludge lagoon was contaminated with PAHs and ^{99}Tc, Sediment in this lagoon was contaminated with PAHs, Tc, and uranium.

The balance of Outfall 001 is included in this removal action due to its designation as a Category 1 outfall by the SWSC PCT (Section 1.2). A discussion of the SWSC PCT assessment of the source, nature, and extent of contamination in the balance of Outfall 001 is presented in Section 1.5.1.1.

Previous Investigations

The previous sampling results for the ditches that flow into Outfall 001 are from Phase 11, the Waste Area Group (WAG) 22, SWMUs 7 and 30 RI, and the WAG 27 RI. Surface water samples taken at the outfall detected ^{99}Tc at 99 pCi/l, uranium-234 at 4.7 pCi/l, and uranium-238 at 13.4 pCi/l. Sediment sampling identified the following contaminant levels in the Outfall 001 area: ^{99}Tc at 41 pCi/g, uranium-234 at 3.8 pCi/g, uranium-238 at 7.5 pCi/g, plutonium-239 at 80 pCi/g, and thorium-230 (Th-230) at 1.4 pCi/g. No previous risk assessments have been performed specifically for the Internal Plant Ditches to Outfall 001.

Previous Response Actions

The Commonwealth of Kentucky has issued two NOVs during the past 10 years for this outfall (total residual chlorine in 1997 and whole effluent toxicity in 1999). The DOE issued **an** *Interim Corrective Measures Work Plan* ***for*** *Institutional Control* ***of*** *Offsite Contamination in Surface Water* (DOE 1992) to restrict casual public access to creeks, outfalls, and lagoons in response to concerns about the presence of PCBs and radiological contamination in the outfalls of PGDP. This corrective measure included the installation of fencing and the posting of warning signs at various offsite locations at the PGDP, including Outfall 001. At the KPDES monitoring point for Outfall 001 and at New Water Line Road, warning signs were installed stating that the ditch is contaminated and should not be used for drinking, recreational, or fishing purposes.

1.4.1.2 Outfall 008

Outfall 008 receives drainage from an area of approximately 36.52 ha (90.4 acres), which includes the internal plant ditches that drain to it. The internal plant ditch system to Outfall 008 is a receiving system that is approximately 2,723 m (12,215 ft) in length, unlined, and ranges from approximately 0.15 to 1.2 m (0.5 to 4 ft) deep. The reported monthly average flow through Outfall **008** is 1.22 mgpd. The KPDES permit for Outfall 008 is maintained by the **USEC.** A conceptual model of the outfall is presented in Figure 1.8.

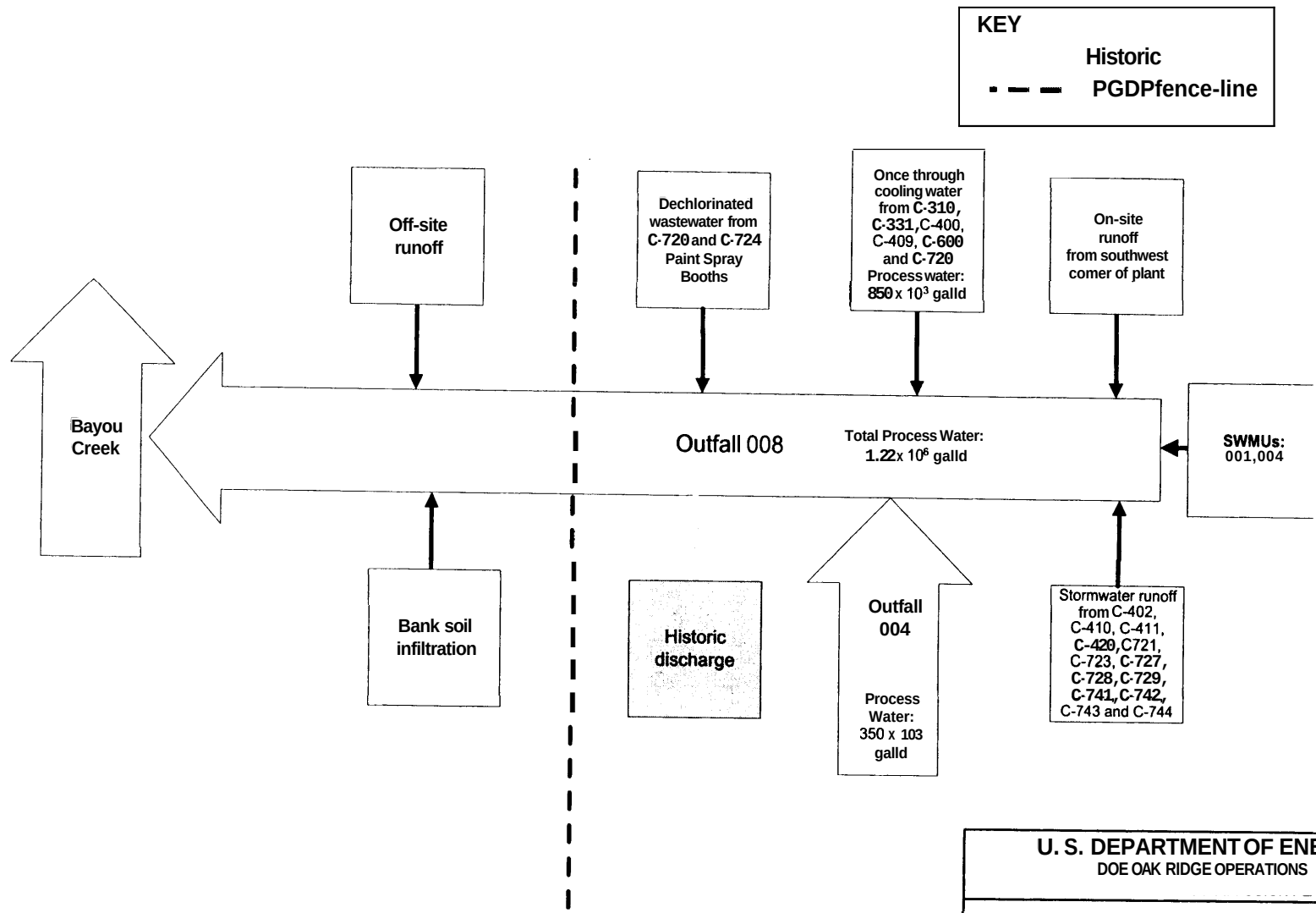

Fig. 1.8. Conceptual model of Outfall 008.

U. S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS

JACOBS Bechtel Jacobs Company LLC

MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee ● Paducah, Kentucky ● Portsmouth, Ohio

SAIC

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Oak Ridge, Tennessee 37831

FIGURE No. C5AC90001SK249.ppt
DATE 01-18-02

Outfall 008 receives multiple wastestreams from the southwest comer of the plant and discharges into Bayou Creek. These sources include storm water runoff from the surrounding area and flow from the Waste Water Treatment Plant that discharges through Outfall 004 into Outfall 008. Specific facilities that drain into Outfall 008 via the internal plant ditches include the following: the C-615 Sewage Disposal Plant (C-615-A Primary Settling Tank, C-615-B Final Settling Tank, C-615-C Control Building, C-615-D Digester, and C-615-E and C-615-F Trickling Filters) (SWMU 38); the C-747-C Oil Landfarm (SWMU 1); the C-745-A and C-746-H Cylinder Storage Yards; the C-747 Burial Yard. Because these wastestreams flow to the outfall through the internal plant ditches, contamination from these areas potentially could have been carried via surface water and sediments to the outfall.

The storm sewer that discharges to KPDES Outfall 008 drains numerous facilities in the central portion of the PGDP and receives storm water runoff. Facilities draining into the storm sewer system **to** Outfall 008 include the following: the C-310 Purge and Product Building; the C-331 Process Building; the C-400 Cleaning Building; the C-402 Cleaning Building; the C-409 Stabilization Building; the C-410 Feed Plant; the C-411 Cell Maintenance Building; the C-420 Greensalt Plant; the C-600 Steam Plant and Supporting Facilities; the C-615 Sewage Disposal Plant; the C-720 Maintenance and Stores Building; the C-721 Gas Manifold Storage; the C-724 Cleaning Facility; the C-729 Acetylene Building; the C-741 Mobile Equipment Building; the C-742 Cylinder Storage Building; the C-743 Office Building, and the C-744 Lubrication Building.

Primarily, the contaminant migration pathway is considered to be sediment and surface water contamination in the ditches to Outfall 008. Releases of any contamination present in the ditches to Outfall 008 likely would occur during high-flow rain events due **to** the increased volume of surface water runoff present at these times. The internal plant ditches that lead to Outfall 008 also may be a minor contributor to contamination in the Northwest Plume; however, this is unlikely because surface water contained in these ditches tends to flow to the outfall rather than infiltrate into the subsurface.

SWMU 38, the C-615 Sewage Disposal Plant, is part of the Outfall 008 drainage area and has been in operation since the plant was built in 1951. The facility receives effluent discharges from within the PGDP and treats those effluents prior to discharge to Outfall 004. All 004 discharges now go through Outfall 008 prior to release to Bayou Creek. Potential contaminants from this waste source include PCBs and uranium [from the *Report for Environmental Audit Supporting Transition of the Gaseous Diffusion Plants for the United States Enrichment Corporation,* DOE/OR/1087&D4 *(DOE* 1993a)].

Outfall 008 is included in this removal action due to its designation as a Category 1 outfall by the **SWSC** PCT (Section 1.2). A discussion of the SWSC PCT assessment of the source, nature, and extent of contamination in Outfall 008 is presented in Section 1.5.1.2.

Previous Investigations

Previous investigations were conducted at the PGDP to characterize the contamination levels at Outfall 008 and the internal ditches that flow into it. The WAG 27 investigation provided sampling results. The surface water samples within the ditches of Outfall 008 detected ^{99}Tc at one of the three internal ditch samples, detecting the radionuclide at 8 pCi/L. At the outfall the following detections were found: ^{99}Tc at 37 pCi/L, uranium-234 at 6.8 pCi/L, and uranium-238 at 7.1 pCi/L. The sediment samples detected contaminants at the outfall in the following levels: plutonium-239 at 80 pCi/g, ^{99}Tc at 2.3 pCi/g, uranium-234 at 2.14 pCi/g, and uranium-238 at 2.6 pCi/g. Additional sample information, such as surface soil samples associated with the ditches, can be found in the Phase I and II **SI,** the WAG 23 RI Addendum, and the WAG 27 RI. No previous risk assessments have been performed specifically for the Internal Plant Ditches to Outfall 008.

During the Phase I **SI,** TCE and several of its direct degradation products were detected in sediment collected from Outfall ditch 008. **A** tributary of Big Bayou Creek, Outfall 008 is noted as being of particular concern because of the high levels of mixed hydrocarbons in sediment (CH2M HILL 1991). The Phase II **SI** found no PCBs in Outfall 008 (CH2M HILL 1992).

Previous Response Actions

The Commonwealth of Kentucky has issued one NOV during the past 10 years for this outfall (total chlorine exceedances reported in December 1996 and January 1997). There have been no previous CERCLA response actions for the internal plant ditches or the storm sewer system to Outfall 008. Past non-CERCLA response actions included the construction of an oil containment lagoon and oil control structure at SWMU 63 in the early 1980s to contain discharges of oil released to Outfall 008 from operations in the C-600 Steam Plant. Additional response actions that have been conducted at the external plant ditches include the interim action documented in the *Interim Corrective Measures Work Plan for Institutional Control of 0)-Site Contamination in Surface Water* (DOE 1992). This work plan was implemented by DOE to restrict public access to creeks, outfalls, and lagoons surrounding the PGDP and involved the installation of fencing and warning signs at various off-site locations along creeks and ditches to address concerns about the presence of PCBs and radiological contamination. No other remedial actions have been taken to address potential contamination at SWMUs contained within the Outfall 008 drainage area.

1.4.1.3 Outfall 015

Outfall 015 lies on the west side of the PGDP and receives drainage from an area of approximately 19.8 ha (49 acres), including the internal plant ditches that drain to it. The internal plant ditch system to Outfall 015 is approximately 3,252 m (10,665 ft) in length, unlined, and ranges from approximately 0.15 to 1.5 m (0.5 to 5 ft) deep. Outfall 015 collects and discharges untreated storm-water runoff collected from the west side of the plant. The reported monthly average flow for Outfall 015 is 0.281 mgpd. DOE is responsible for Outfall 015 under the KPDES Permit. **A** conceptual model of the outfall is presented in Figure 1.9. While sediment control measures, such as berms, are present in Outfall 015, the potential for bypass and migration of contaminated sediment to Bayou Creek does exist during excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls).

Specific facilities contained in the Outfall 015 drainage area that drain via the internal plant ditches are the C-400 Cleaning Building; the C-405 Contaminated Items Incinerator **(SWMU** 55); the C-616-L Pipeline and Vault Soil Contamination **(SWMU** 165); the C-749 Uranium Burial Ground **(SWMU 2);** the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground (SWMU 3); the C-745-A Cylinder Storage Yard; the C-747 Burial Grounds **(SWMU** 4); the UF_6 Cylinder Drop Test Area (SWMU 91); the C-745-B Cylinder Storage Yard; and some of the C-745-C cylinder yards.

Outfall 015 is included in this removal action due to its designation as a Category 1 outfall by the SWSC PCT (Section 1.2). **A** discussion of the SWSC PCT assessment of the source, nature, and extent of contamination in Outfall 015 is presented in Section 1.5.1.5.

Previous Investigations

Contamination in the sediments of Outfall 015 has been characterized in several previous investigations. During the Phase I SI (CH2M HILL 1991) ^{99}Tc, uranium-234, and uranium-238 were detected in the sediments, making Outfall 015 a potential route of contaminant transport. The Phase II **SI** results (CH2M HILL 1992) confirmed the presence of radionuclide contamination (^{99}Tc, uranium-234, thorium-230, plutonium-235, uranium-235, and uranium-238) in sediments at Outfall 015 and also identified the presence of metals (aluminum, cobalt, copper, thallium, and zinc) in sediments. Investigation of sediment contamination

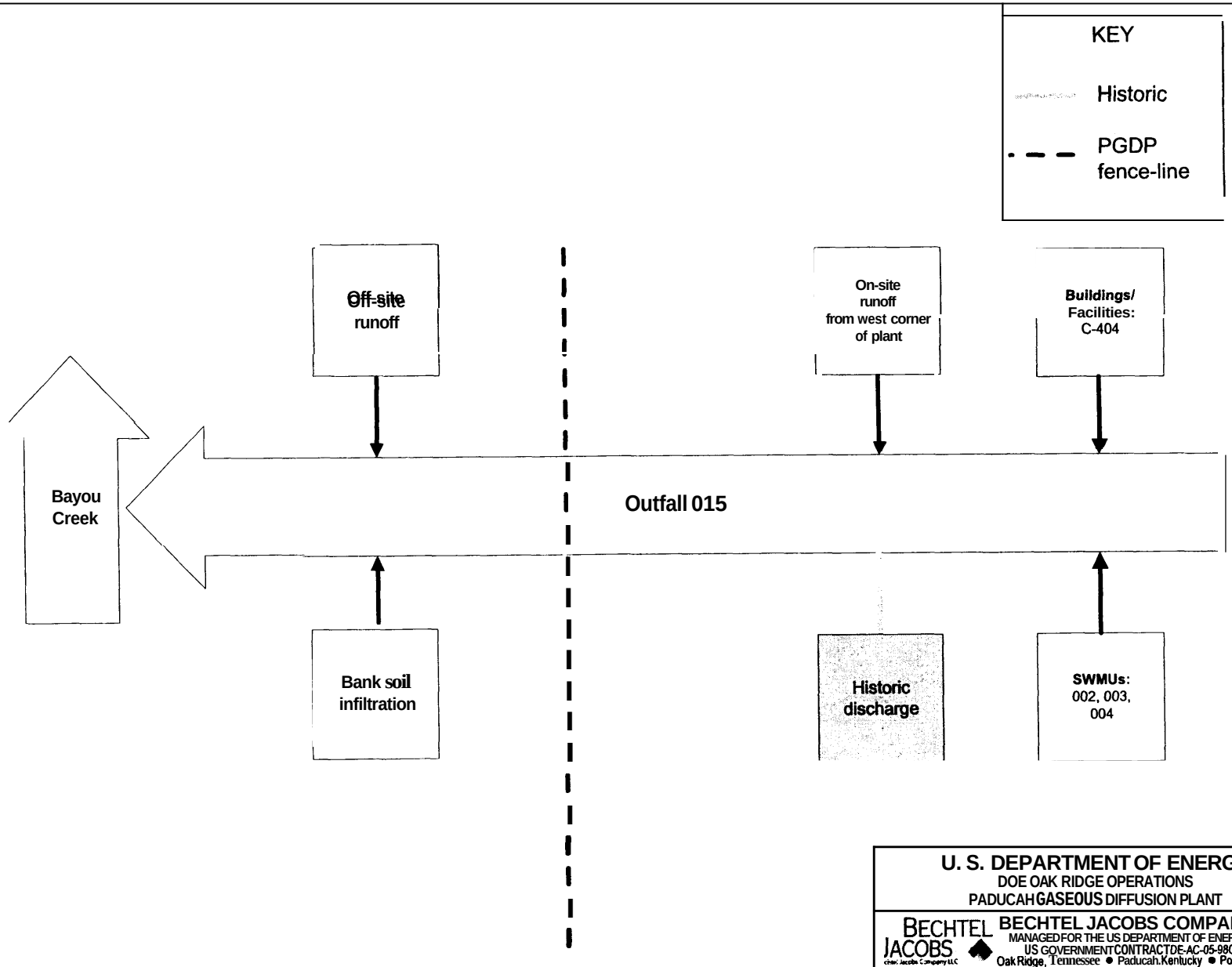

Fig. 1.9. Conceptual model of Outfall 015.

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FIGURE No. C5AC90001SK246.ppt
DATE 01-18-02

in the internal plant ditches feeding Outfall 015 also was included as part of the *Remedial Investigation Addendum for WAG 22 Burial Grounds at Paducah Gaseous Diffusion Plant* (DOE 1993b). Radionuclides, particularly uranium, were detected in the ditch leading from the C-749 Uranium Burial Ground (SWMU 2) to Outfall 015. The report further states that the unit (SWMU 2) is covered with a low-permeability cap indicating the observed contamination may be a result of historical discharges (DOE 1993).

Previous Response Actions

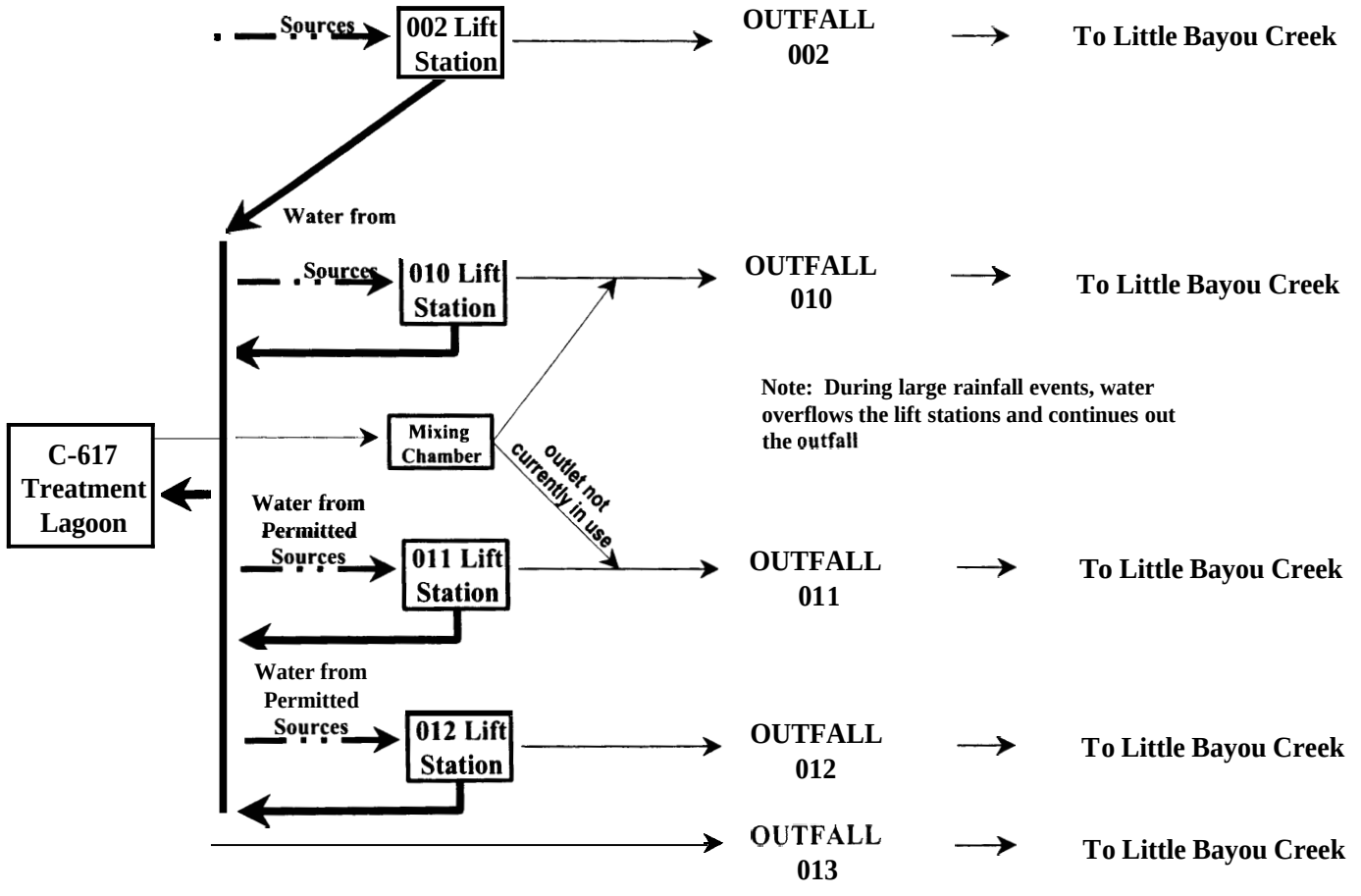
There have been no previous response actions and no NOVs in the past 10 years for the internal plant ditches to Outfall 015. However, due to concerns about the presence of PCBs and radiological contamination in outfalls at the plant, the DOE issued the *Interim Corrective Measures Work Plan for Institutional Control of Off-Site Contamination in Surface Water* (DOE 1992). The Interim Corrective Measures restrict access to the creeks, outfalls (including Outfall 015), and lagoons surrounding PGDP 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 areas of contamination were identified through the posting of warning signs. Subsequently, in 2000, additional warning signs that identify the ditch as a contaminated area were posted at Outfall 015.

1.4.2 East Side Outfalls

On April 1, 1998, USEC assumed responsibility for the KPDES permits for Outfall 010 and 011, located on the East Side of the plant. In October 1991, DOE began operation of the C-617 Complex, a system of sumps in the outfall ditches, pumps, pipelines, and lagoon, to capture and treat effluents released to the east ditches (Outfalls 002, 010, 011, and 012). The ditch sumps are located 9.1 m (30 ft) east of the storm sewer headwall in each ditch. These sumps collect all flow in the ditches coming from the storm sewer system; the collected flow then is pumped through a series of lift stations into the C-617 Treatment Lagoon (Figure 1.10) for treatment of residual chlorine (with sodium thiosulphate), adjustment of pH (with carbon dioxide), and moderation of excess temperature during normal operation. After treatment, the commingled wastewater flows by gravity to a mixing chamber located between Outfalls 010 and 011. Treated effluent from this mixing chamber is then discharged to Little Bayou Creek. Onginally, Outfall 011 was used to discharge the treated effluent to Little Bayou Creek; however, due to concerns regarding PCB contamination in Outfall 011, regular discharge of the treated effluent was switched to Outfall 010 after June 8, 1994. Currently treated effluent is released into Outfall 011 only during those times when maintenance is being performed on the lift station at Outfall 010.

As stated above, the C-617 Complex captures and treats all flow from Outfalls 002, 010, 011, and 012 during normal operating conditions. However, during large rainfall events (those greater than 0.5 inches/hour), regular plant effluent may exceed the capacity of the collection sumps at the individual outfalls and any overflow is discharged directly to Little Bayou Creek.

The East Side outfalls discharge into the Little Bayou Creek. This creek was included on the Clean Water Act Section 303 (d) list of impaired waters for not meeting aquatic life and fish consumption criteria for its designated use. Commonwealth of Kentucky Officials have developed a PCB TMDL of 0.0 lbs/day or 0.0 mg/kg (or 0 ppm for sediments) for the Little Bayou Creek in order to meet guidelines set by the EPA for a Warm Water Aquatic Habitat. This TMDL currently is awaiting final approvals from EPA. If monitoring in accordance with the KPDES permit indicates that exceedances of the designated TMDL are occurring, these exceedances will be evaluated and corrective responses will be undertaken as a CERCLA action separate from this removal action.



LEGEND

- INFLUENT TO C-617 TREATMENT LAGOON
- WATER FROM PERMITTED SOURCES
- OVERFLOW DISCHARGE TO OUTFALLS
- DISCHARGE FROM C-617 TREATMENT LAGOON

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Fig. 1.10. Diagram of operation of Outfall Ditches 002,010, 011,012, and 013 at PGDP.

FIGURE No. 0992-1-7
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1.4.2.1 Outfall 010

Outfall 010 receives drainage from an area of about 8.78 ha (22 acres) including the internal plant ditches that drain into it. The internal plant ditch system to Outfall 010 is approximately 687 m (7,400 ft) in length, unlined, and approximately 0.6 m (2 ft) deep. The reported monthly average flow is 0.56 mgpd. A conceptual model of the outfall is presented in Figure 1.11. Outfall 010 is equipped with a containment dam that can be used, if necessary, during releases.

Facilities draining into Outfall 010 drainage area includes the C-331 Process Building and the C-531 area [including the C-531-1 Switch House and Appurtenant Structures (C-531-3A and C-531-B Fire Valve Houses) and the C-531-2 Electrical Switchyard (SWMU 82)]. Other areas that drain to Outfall 010 include the C-617-B Lagoon, the C-746-D Scrap Yard (SWMU 16), and the C-746-E Cylinder Storage Yard. The C-331 Process Building drains to the outfall via the storm sewer system. Contamination from the C-531 area, the C-745-E Cylinder Storage Yard, and the C-746-D Scrap Yard likely has been carried via surface water and sediments to 010.

Discharges from Outfall 010 are collected in a sump and pumped to the C-617-B Treatment Lagoon (Figure 1.10). From this mixing chamber the wastewater can be directed to either Outfall 010 or 011; however, due to contaminant concerns that arose in the mid-1990s, the DOE decided that effluent discharges from the mixing chamber typically would be directed to Outfall 010.

The primary migration pathway is considered to be sediment and surface water contaminant migration via the storm sewer system; however, sediment and surface water contaminant migration in the ditches to Outfall 010 likely occurs. Release of contaminants to the ditches likely occurs during rain events that exceed the capacity of the lift stations, resulting in potentially untreated discharge. Contamination from the C-531 area, the C-745-E Cylinder Yard, and the C-746-D Scrap Yard likely has been carried via surface water and sediments to Outfall 010.

Outfall 010 is included in this removal action due to its designation as a Category 1 outfall by the SWSC PCT (Section 1.2). A discussion of the SWSC PCT assessment of the source, nature, and extent of contamination in Outfall 010 is presented in Section 1.5.1.3.

Previous Investigations

The KPDES permit regulates water quality by requiring a monitoring station where water quality is tested regularly, in accordance with the permit. Monitoring results demonstrate that overall the quality of the discharge water meets KPDES limits; however, sporadic detections of PCBs have persisted. The primary investigations that characterize the contaminant levels in sediments and surface water of the effluent ditches are the Phase I and Phase II SI of the PGDP (CH2M HILL 1991 & 1992), a site evaluation of effluent ditches 010,011, and 012 (DOE 1995), and a 1996 PCB study of the COE (COE 1996).

The Phase I and II SIs conducted sampling at several locations within the internal ditches of Outfall 010 in order to characterize the surface water contamination. The samples taken from the internal ditches and the Outfall identified contamination as the following: ^{99}Tc has been identified at Outfall 010 surface water as high as 116 pCi/l and TCE at 3µg/l. PCBs were not detected in the surface water. The primary sediment contaminants found in the 010 effluent ditch were dioxins, PCBs, and metals.

Previous Response Actions

There have been no previous response actions and no NOVs in the last 10 years for the internal plant ditches to Outfall 010 or for the storm sewer system to Little Bayou Creek Outfalls. With Interim Corrective

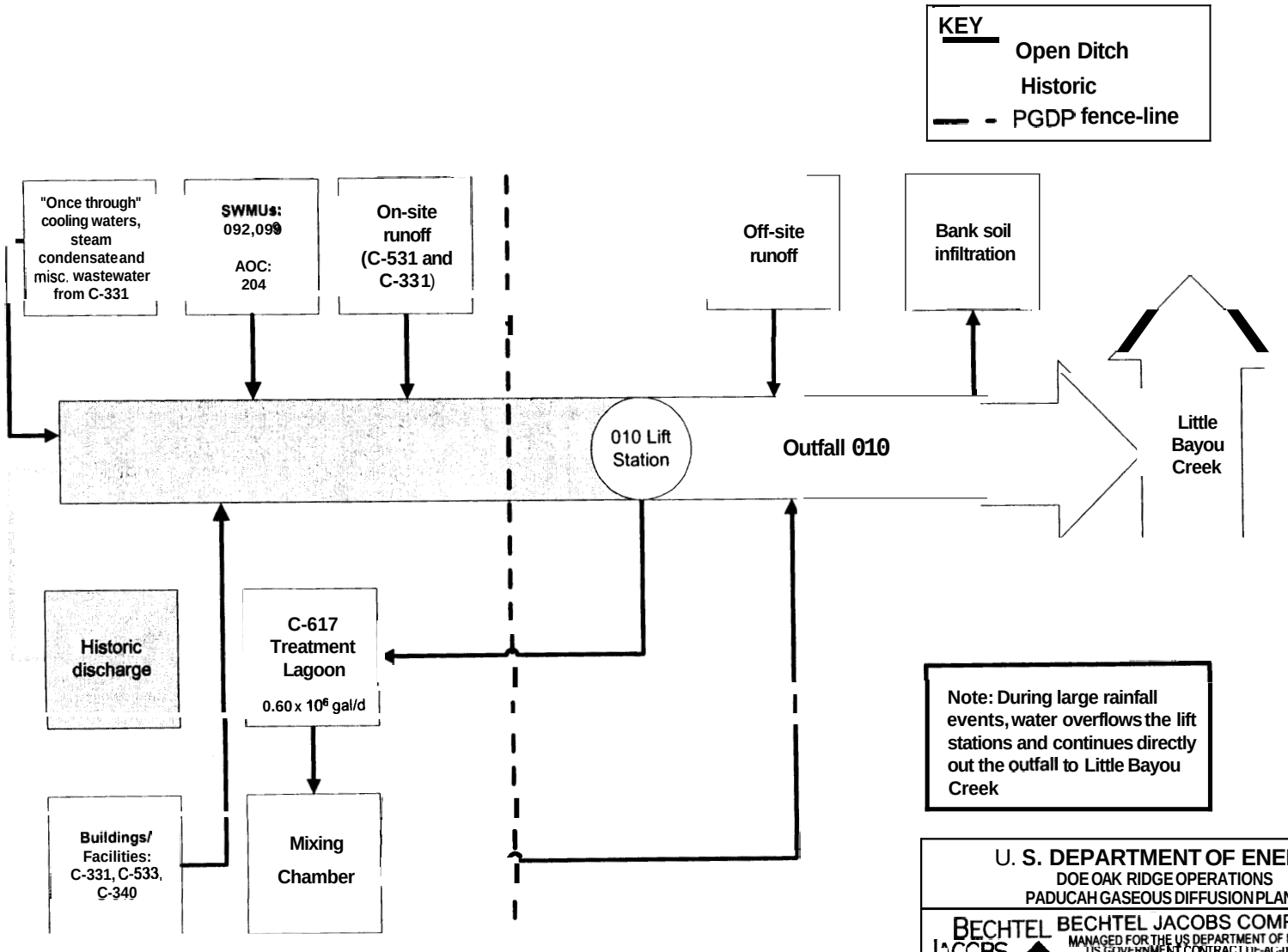

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Fig. 1.11. Conceptual model of Outfall 010.

Measures ***Work*** *Plan for Institutional Control of Off-site Contamination in Surface Water* (DOE 1992), the DOE restricted casual public access to creeks, outfalls (including Outfall 010), and lagoons surrounding the PGDP in 10 locations through the installation of fencing and identified the areas of contamination through the posting of warning signs.

1.4.2.2 Outfall 011

Outfall 011 is located on the East Side of PGDP and receives drainage from **an** area of approximately 12.5 ha (31 acres), including the area of the internal plant effluent ditches. The internal plant ditch system to Outfall 011 is approximately 1,646 m (5,400 ft) in length, unlined, and approximately 0.61 m (2 ft) deep. The reported monthly average flow for Outfall 011 is 0.34 mgpd. A conceptual model of the outfall is presented in Figure 1.12.

The drainage area for Outfall 011 encompasses the C-315 Surge and Waste Building; the C-331 and C-333 Process Buildings; the C-340 Reduction and Metals Facility; the C-352 Relay House; C-532 Relay House; and the C-533-1 Switch House and Appurtenant Structures. Other areas that drain into Outfall 011 include SWMUs 56 and 80 of WAG 23.

Discharges from Outfall 011 are collected in a sump and pumped to the C-617-B Treatment Lagoon (Figure **1.10)** for treatment of residual chlorine, pH, and excess temperature. Currently, Outfall 011 receives discharges of effluent from the C-617-B Lagoon only when maintenance is being performed on the lift station located in Outfall 010. Outfall 011 may receive additional wastestreams when Lift Station 011 is bypassed due to failures, maintenance, or excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls). During such bypass events, the water discharged through Outfall 011 proceeds to Little Bayou Creek. Mechanical failure and maintenance activities, such as cleaning the underflow weir (installed in 1991), which occur on an as-needed basis.

Outfall 011 is included in this removal action due to its designation as a Category 1 outfall by the SWSC PCT (Section 1.2). **A** discussion of the SWSC PCT assessment of the source, nature, and extent of contamination in Outfall 011 is presented in Section 1.5.1.4.

Previous Investigations

Several previous investigations have been conducted at the PGDP to characterize contaminant levels in the sediments of Outfall 011. During the Phase I **SI** (CH2M HILL 1991), Outfall 011 was identified as a likely route of contaminant transport due to the presence of radionuclides (^{99}Tc, thorium-230, uranium-234, uranium-235, and uranium-238) and organic contaminants in Outfall 011 sediments. The Phase 11 **SI** (CH2M HILL 1992) confirmed these results and also identified metals contamination (chromium, copper, zinc and nickel) and PCB (PCB-1248, PCB-1254, and PCB-1260) and PAH contamination in the outfall sediments.

TCE and PCBs both were identified along a limited stretch of Outfall 011 in a site evaluation of effluent ditches 010, 011, and 012 (DOE 1995). The highest TCE concentrations in the soil and groundwater and in the ditch sediment occur within a 50 ft reach of Outfall 011 between Dykes Road and the lift station. No evidence exists to confirm the plant is the source of the TCE detects. The close association of the two contaminants suggests that the two may have a common origin. A PCB study conducted by the COE (COE 1996) confirmed the presence of PCBs in Outfall 011 sediments. Outfall ditch 011 was the site of a PCB cleanup in 1983. Historical records indicate that the PCB cleanup level for the remediation was 25 ppm (DOE 1997).

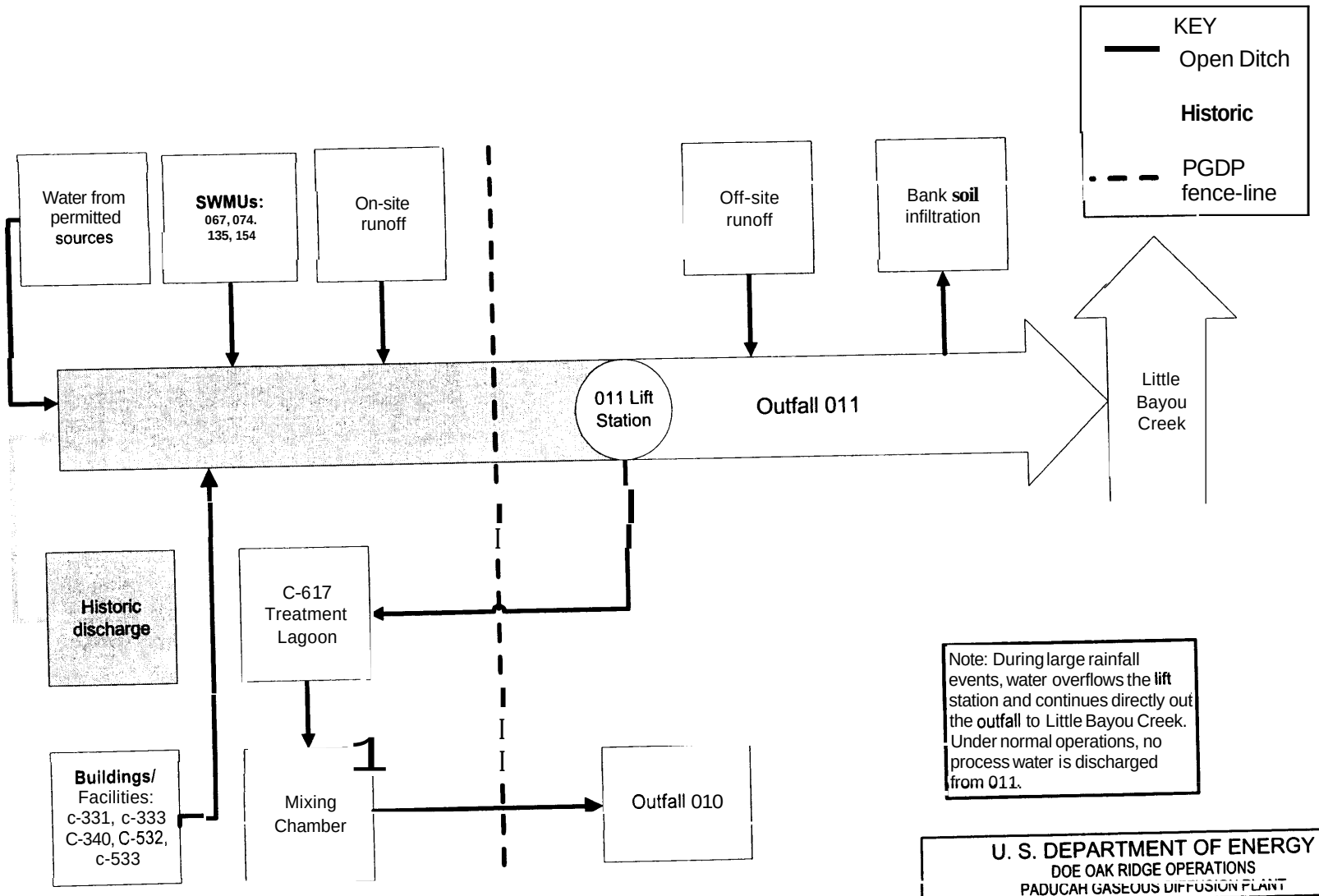

Fig. 1.12. Conceptual model of Outfall 011.

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Previous Response Actions

There have been no previous CERCLA response actions for the internal plant ditches to Outfall 011; however, the 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, the DOE excavated the upper 0.46 m (1.5 ft) of sediments 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. This was followed in 1992 by the issuance of the *Interim Corrective Measures Work Plan for Institutional Control of Off-Site Contamination in Surface Water (DOE* 1992) due to the continued presence of PCBs and radiological contamination in surface water discharged through outfalls at the plant. The Interim Corrective Measures restricted access to the creeks, outfalls (including Outfall 011), and lagoons surrounding PGDP 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 areas of contamination were identified through the posting of warning signs. Subsequently, in 2000, additional warning signs that identify the ditch as a contaminated area were posted at Outfall 011.

In 1994 the DOE received two NOVs 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 were 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.

In an effort to minimize/eliminate further PCB releases at the PGDP, the 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 ppm) 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 inches) 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 (Table 1.4). For each sampling event the 15.24 m (50 ft) section test area was divided into 3 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 demonstration segment to levels of approximately 10 ppm. However, test results indicating further reduction of contaminant levels below 10 ppm were inconclusive (Milne 1997).

Table 1.4. Test Results of the Nature's Way Bioremediation Technology Field Demonstration

Date	Feb 1995"	May 1996	Aug 1996	Oct 4,1996	Nov 13,1996
Section #1	34.0 mg/kg	5.6 mg/kg	9.4 mg/kg	4.7 mg/kg	4.5 mg/kg
Section #2	24.4 mg/kg	6.2 mg/kg	7.1 mg/kg	2.5 mg/kg	6.6 mgkg
Section # 3	—	17.4 mg/kg	11.0 mg/kg	8.7 mg/kg	5.3 mg/kg
Average	29.2 mg/kg	9.73 mg/kg	9.17 mg/kg	5.3 mg/kg	5.5 mgkg

No other previous response actions have occurred at this outfall.

1.5 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The source, nature, and extent of chemical contamination within the watersheds of the 17 outfalls at PGDP have been the subject of numerous investigations (Section 1.4). Fourteen of these outfalls are currently active and **12** outfalls are identified as SWMUs or AOCs. The contamination present in these 12 outfalls was derived from various historical plant activities conducted at PGDP facilities and includes metals, dioxins/furans, PCBs, radionuclides, semivolatiles, and volatiles.

DOE, EPA, and the Commonwealth of Kentucky have agreed that preventing off-site migration of contaminants is the highest site-wide **priority** for nonemergency clean-up activities at PGDP, and that containment/prevention/minimization of potential surface water discharges of contaminants from PGDP is the highest priority for the **SWOU.** In early 2000, DOE, EPA, and the Commonwealth of Kentucky agreed to establish a technical worlung group known as the SWSC PCT. This team consists of representatives from DOE, EPA, and the Commonwealth and was established with the intent of providing a mechanism to build consensus among the parties of the PGDP **FFA** in an effort to expedite the scoping, planning, and development process for site characterization and removal/remediation activities (including the development, review, and approval of CERCLA decision documents).

While periodic monitoring at PGDP indicates that, overall, the five outfalls generally are in compliance with their KPDES permits (only 4 NOVs have been issued for these outfalls during the past **10** years), the parameters monitored under these permits do not address all CERCLA contaminants of potential concern (COPCs) that may be present within the outfall watersheds. The potential discharge of these CERCLA COPCs in the form of dissolved phase contaminants or contaminated sediments that exceed human health risk levels of 1×10^{-4} for a child recreator and ecological risk levels of an HI of 3 could exist at these five outfalls if specific situations were to occur. These situations include excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls); infrequent off-normal conditions, such as maintenance activities, when existing runoff and sediment control measures are inoperable; the remediation of up-gradient SWMUs within the watershed that could disturb and mobilize contaminated surface and shallow subsurface soil and, therefore, represent the potential for surface water discharge of contamination; or the occurrence of new upgradient contamination with the potential for off-site transportation via storm runoff. Additional monitoring to address specific CERCLA COPCs in both discharged sediment and surface water also is included as part of each alternative proposed by this removal action.

1.5.1 Assessment of Category 1 Outfalls

For each outfall, the SWSC PCT compared soil and surface water contaminant concentrations within the binning package datasets (see Section 1.3) to the human health risk action level (>1 x 10'') for a child recreator. In addition, a review was made of all remedial activities planned for SWMUs located within the watershed of each outfall. If these reviews indicated the potential for contaminant discharge through the outfall, the outfall was binned into Category 1 (requires action). A summary of the SWSC PCT assessments of Outfall 008, 010, 011, 015, and the balance of 001 are presented below. Since this removal action does not address the outfalls binned into Categories 2 or **3,** no detailed assessment information is provide for those outfalls.

1.5.1.1 Balance of Outfall 001

Figure 1.13 shows the watershed for the balance of Outfall 001 and all sampling points retained within the binning dataset for consideration by the SWSC PCT. Table 1.5 summarizes the analytical information contained in the binning dataset for the balance of Outfall 001. Table I.6 summarizes soil/sediment samples that exceeded human health action levels (1 x 10'') for a child recreator. No surface water samples exceeded these action levels. Figure 1.14 shows the SWMUs present within the outfall watershed and the location of the soil/ sediment and surface water samples that exceeded the human health action levels (1 x 10'') for a child recreator.

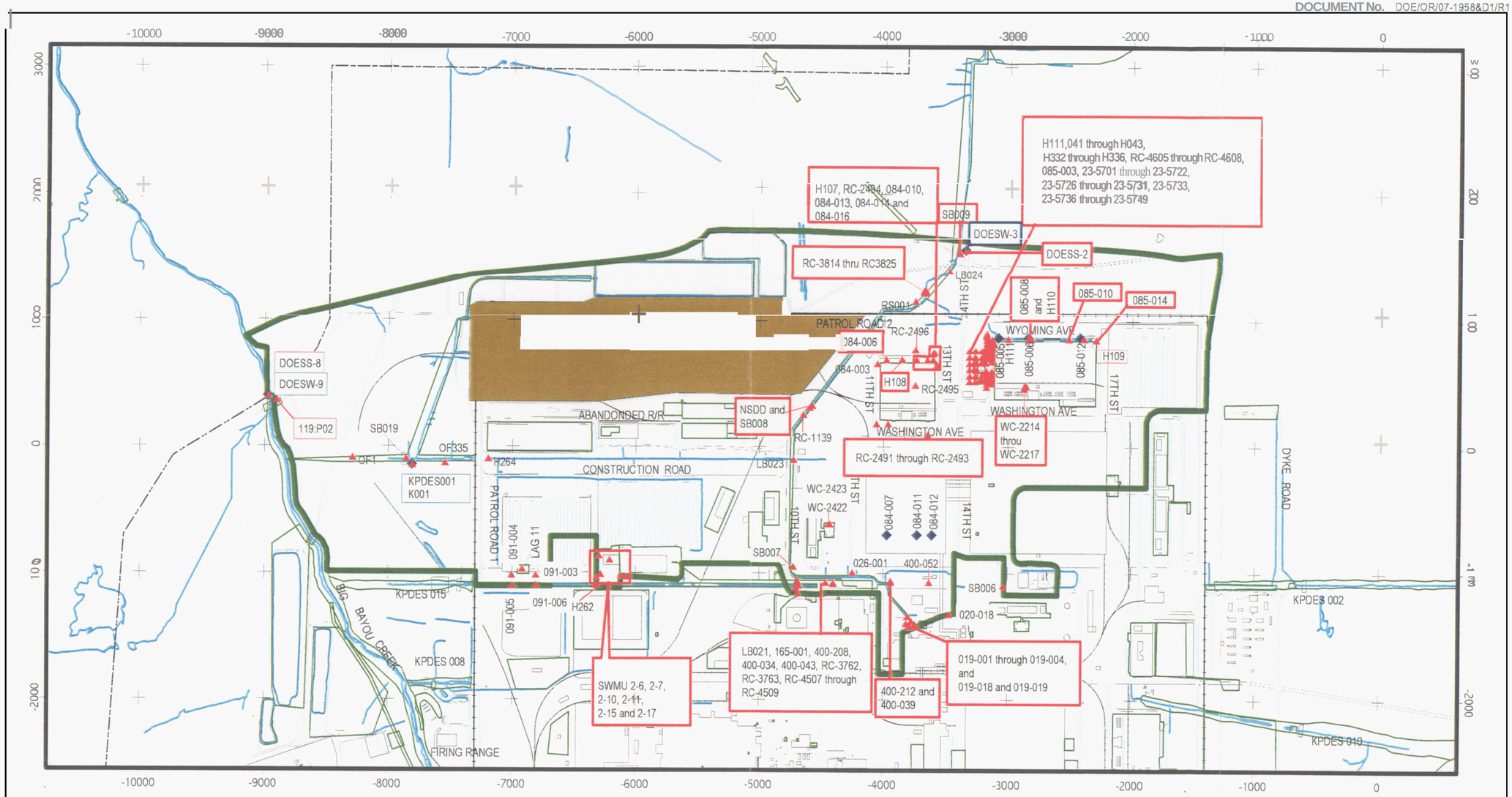


Fig. 1.13 Sampling locations within Outfall 001 watershed.

Table 1.5. Summary of dataset for balance of Outfall 001

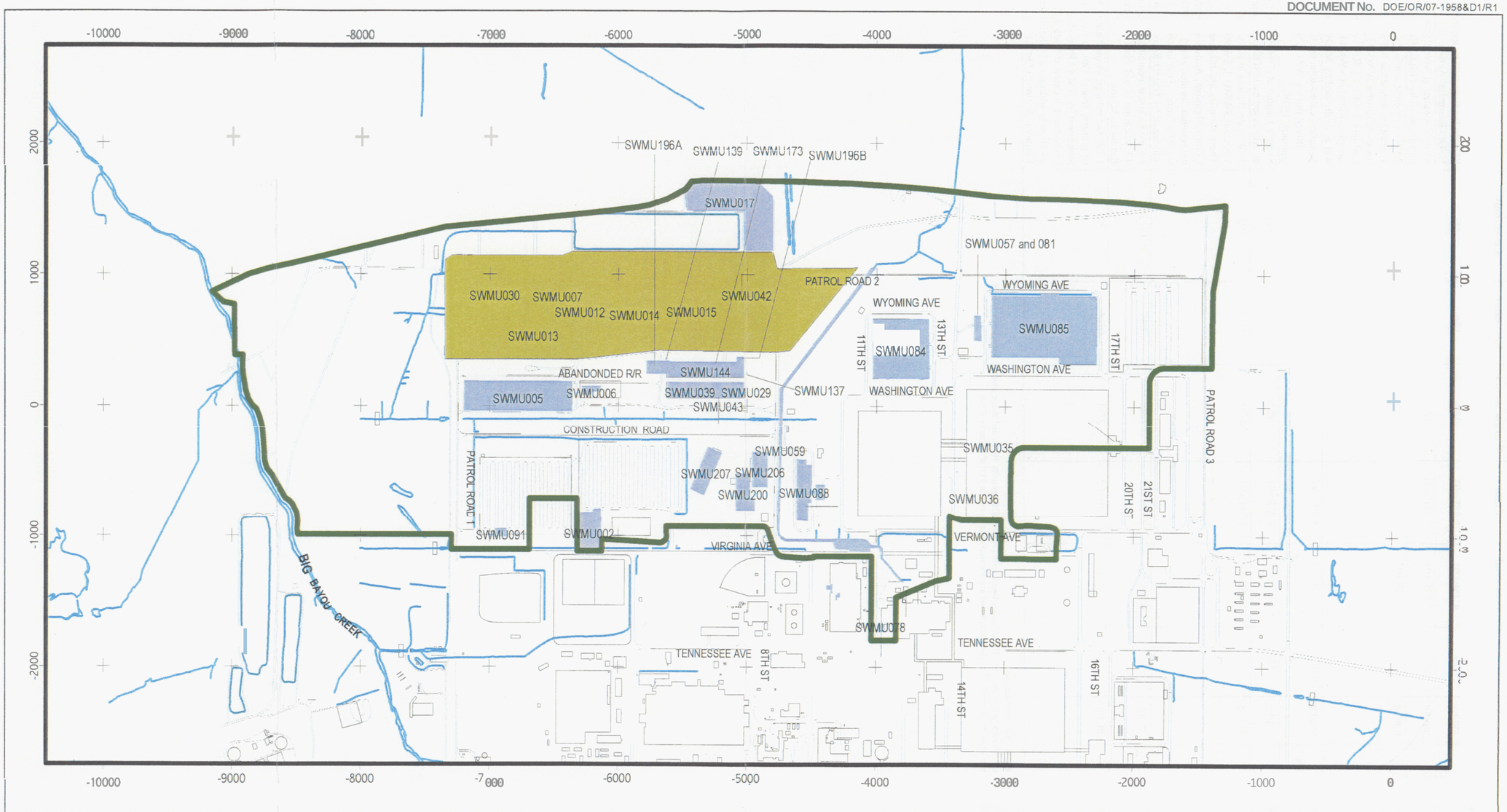
Environmental Media	Analytical Group Tested	Number of Samples Tested
Sediment	Metals	6
	PCBs	17
	Radionuclides	22
	Semivolatile organic aromatics	6
	Volatile organic aromatics	11
Soil[a]	Dioxin/Furans	9
	Metals	85
	PCBs	117
	Radionuclides	71
	Semivolatile organic aromatics	25
	Volatile organic aromatics	16
Surface Water	Metals	57
	Metals – Dissolved	4
	PCBs	46
	Radionuclides	50
	Radionuclides – Dissolved	4
	Semivolatile organic aromatics	6
	Volatile organic aromatics	46

[a] All soil samples included in the dataset were collected from 0 to 1 ft bgs.

Table 1.6. Outfall 001 − Comparison of analyte detections in sediment and soil to child recreator action levels

Analytical Group	Analyte	Units	Maximum Detect	Industrial Worker Action Level[a]	Child Recreator Action Level	FOD above Industrial Worker Action Level (all samples)[b]	FOD above Child Recreator Action Level all sam les [b]	FOD above Child Recreator Action Level (only samples outside of security fence)[c]	Notes
PCBs	PCB-I248	mg/kg	29	4.25E+01	2.83E+01	0/96		1/7	Sample location will be excavated during NSDD Remedial Action.
PCBs	PCB-1254	mg/kg	292	1.82E+01	7.81E+00	1/99		018	Sample located at SWMU 88. Location will be addressed by NSDD Remedial Action.
PCBs	PCB-1260	mg/kg	370	4.25E+01	2.83E+01	2/99	3/99	017	2 IW exceedances and 2 CREC exceedances at samples located at SWMU 81. These were removed during WAG 23 Removal Action (January 1998). 1 CREC exceedance at sample located at SWMU 88. This location will be addressed by NSDD Remedial Action.
Dioxin/furans	Pentachloro-dibenzo(b,e)(1,4) dioxin	mg/kg	0.00106	1.24E-03	8.29E-04	016	1/6	0/0	Sample located adjacent to SWMU 81. Removed during WAG 23 Removal Action (January 1998).
PCBs	Polychlorinated biphenyl	mg/kg	330	4.25E+01	2.83E+O1	1/53	1/53	0/16	Sample located at SWMU 88. Location will be addressed by NSDD Remedial Action.
Radionuclides	Cesim-137	pCi/g	51	1.05E+01	2.18E+01	4/32	3/32	0/2	3 IW exceedances and 3 CREC exceedances located at SWMU 2, SWMU 3, or in Outfall 15. These samples are addressed by Sediment Control Removal Action at Outfall 15. 1 IW exceedance located along NSDD north of security fence. This location will be addressed by NSDD Remedial Action.
Radionuclides	Neptunium-237	pCi/g	63	4.54E+01	9.53E+01	1/47	0/47	0/12	IW exceedance located adjacent to SWMU 42. Location is addressed by Scrap Metal Removal Action.
Radionuclides	Uranium-238	pCi/g	314	3.13E+02	6.60E+02	2/34	0/34	0/9	1 IW exceedaiice located along NSDD north of security fence. This location will be addressed by NSDD Remedial Action. 1 IW exceedancc located at SWMU 2. This location is addressed by Sediment Control Removal Action at Outfall 15.

[a] Industrial Worker Action Levels are provided for information only
[b] Considers all sediment/soil samples within the watershed of the outfall, including those within the PGDP security fence and those outside the security fence.
[c] Considers oiily those sediment/soil samples within the watershed of the outfall that are located outside of the PGDP security fence.



LEGEND

- Streams
- Railroad Tracks
- Roads
- Watershed 001 Boundary
- SWMU locations
- Scrap Metal Yard

Note: Neither soil and sediment nor surface water samples exceeded the child recreator action level

700 0 700 Feet

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FIGURE No. c5ac90001sk251.apr
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Fig 1.14 SWMU locations and exceedances of the child recreator action level within Outfall 001 watershed.

Initial reviews of contaminant concentrations detected in soil within the watershed indicated that five organics (PCB-1248, PCB-1254, PCB-1260, total PCBs, and pentachloro-dibenzo[b,e][1,4]dioxin) and one radionuclide (cesium-137) were present at concentrations that exceeded the child recreator action level. All but one of the samples that contained these exceedances were located in areas excavated during the WAG 23 Removal Action in January 1998 or scheduled for excavation during the upcoming NSDD Remedial Action. Since these areas of contamination have been removed or are scheduled for removal in the near future, they were not considered to be a driver indicating the need for early action.

The remaining samples that exceeded the child recreator action level contained cesium-137. The samples were collected from SWMUs 2 and 3 that are located on the southern boundary of Outfall 001, adjacent to the watershed for Outfall 015. Surface water drainage from these SWMUs is divided between the two outfalls, and the samples containing the cesium-137 exceedances discussed above are located within the area that drains to Outfall 015. The SWSC PCT determined that existing sediment contaminant concentrations present in the balance of Outfall 001 [Condition 1 (as specified in Section 1.2)], based on the available data, did not necessitate that action be taken for the balance of Outfall 001.

Contaminant concentrations in surface water (Condition 2) for the balance of Outfall 001 also were compared to the human health action levels (1×10^{-4}) for a child recreator. No exceedances of this action level were present.

Review of the remediation planned (Condition 3) for SWMUs located in the watershed of the balance of Outfall 001 indicated that replacement of the storm sewers at SWMU 71 (C-337-A Vaporizer) and excavation of soil at SWMU 200 (soil contamination south of Toxic Substances Control Act (TSCA) Waste Storage Facility) was likely within the next two years. The remediation of these SWMUs potentially may result in the mobilization and transport of contaminated soil/sediment to Bayou Creek; therefore, the SWSC PCT determined that action to contain potential contaminant discharge from the balance of Outfall 001 is necessary.

Based on the review of the available data from Outfall 001, the SWSC PCT developed the probable technical responses listed in Table 1.7. The identified uncertainties associated with these probable responses are listed below.

- Future construction or remediation activities could create the opportunity for sediment and contaminated sediment to be mobilized and transported to Bayou Creek.
- Levels of dissolved phase radionuclides and metals being discharged during storm flows.
- Contribution and nature of process water is uncertain during storm events. It is uncertain whether or not this contribution can be evaluated and addressed efficiently.
- Little data exists about current conditions in the east/west ditch, making it difficult to establish whether or not it is contributing to the problem with this outfall.

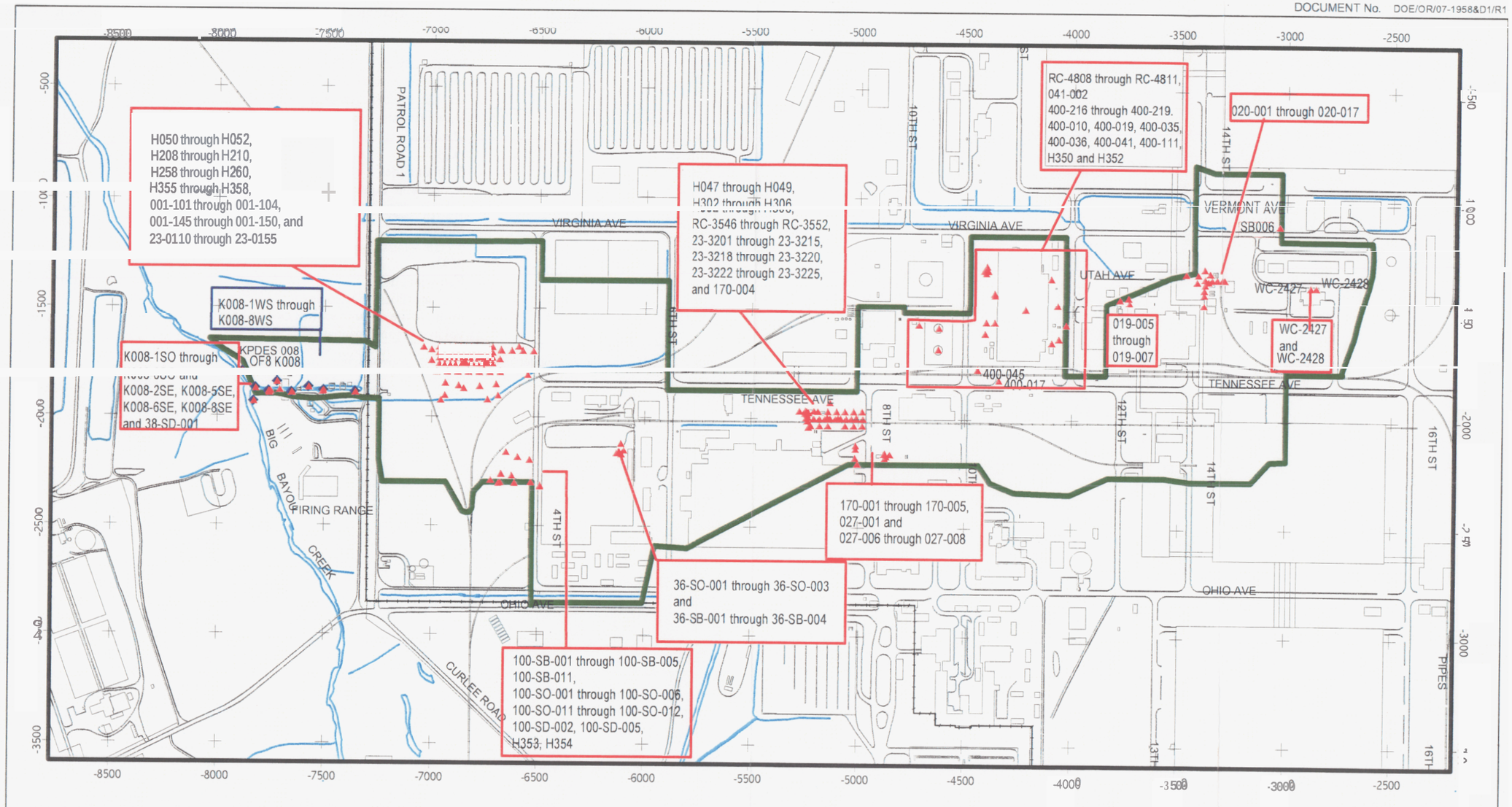
Based on the assessment of the data from the balance of Outfall 001, the SWSC PCT determined that Condition 3 was present. Therefore, the outfall was binned into Category 1 (action required).

1.5.1.2 Outfall 008

Figure 1.15 shows the watershed for Outfall 008 and all sampling points retained within the binning dataset for consideration by the SWSC PCT. Table 1.8 summarizes the analytical information contained in the binning dataset for Outfall **008.** Table 1.9 summarizes soil/sediment samples from this dataset that

Table 1.7. Balance of Outfall 001 Technical Response

Conditions Requiring Response	Problem	Removal Action Objective(s)	Quality Level(s) of Certainty	Likely Response Action(s)
1. Existing sediment contamination	None Identified	Prevent discharge of contaminated sediments/soils from outfall to Bayou Creek. Minimize sediment/soil discharge from the outfall.	High level of certainty that historical discharge of process water has resulted in sediment/soil contamination within the outfall and upgradient to Little Bayou Creek. However, exceedances above acceptable child recreator action levels have not been identified. Low-level of certainty that sediment/soil problem warrants early action based on quantitative data.	Monitoring as a part of the SWOU, and any-action taken as a result of containing sediment discharge from upgradient SWMUs. Integrated and local controls implemented in response to Problem Type 3 (i.e., future potential for discharge of contaminated sediment or dissolved phase contamination) will be used to manage uncertainty as to whether a problem exists in Problem Type 1 (i.e., existing sediment contamination) in balance of Outfall 001.
2. Existing discharge of contaminated sediment or dissolved phase contamination	None Identified	None Required	Low-level of certainty of dissolved contaminant discharge from outfall.	Monitoring during storm flow to determine if dissolved phase contaminants (i.e., metals) are discharged.
3. Future potential for discharge of contaminated sediment or dissolved phase contamination	Existing upgradient contamination and/or near-term remediation of upgradient SWMUs may result in mobilization and discharge of contaminated sediments/soils and dissolved phase contaminants. Uncertainty: See uncertainties listed in Section 1.5.1.1.	Prevent discharge of contaminated sediments/soil from outfall to Bayou Creek. Minimize sediment/soil discharge from the outfall. If a system control is required, develop design of containment system to be compatible with treatment of dissolved phase contaminants of concern.	Moderate level of certainty that future remedial actions at SWMU 200 will contribute contaminated sediment/soil to the ditches. High level of certainty that future remedial actions at SWMU 071 will contribute contaminated sediment/soil.	Implementation of localized controls during upgradient response actions. Containment through integrated controls to meet the 30/60 sediment and contaminant discharge limit up to a 10 year, 24 hour storm event. Containment through system controls integrated with adjacent outfalls.



LEGEND

- Railroad
- Road
- Stream
- Watershed 008 Boundary
- Surface Water Sampling Station
- Soil and Sediment Sampling Station 0 to 1 foot bgs

700 0 700 Feet

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FIGURE No. c5ac90001sk174.apr
DATE 01-22-02

Fig. 1.15 Sampling locations within Outfall 008 watershed.

Table 1.8. Summary of dataset for Outfall 008

Environmental Media	Analytical Group Tested	Number of Samples Tested
Sediment	Metals	6
	PCBs	8
	Radionuclides	7
	semivolatile organic aromatics	4
	volatile organic aromatics	4
	Dioxin/furans	10
Soil[a]	Metals	
	PCBs	183
	Radionuclides	154
	semivolatde organic aromatics	69
	volatile organic aromatics	54
Surface Water	Metals	17
	Metals – Dissolved	5
	PCBs	0
	Radionuclides	20
	Radionuclides – Dissolved	5
	semivolatile organic aromatics	0
	volatile organic aromatics	0

[a] All soil samples included in the dataset were collected from 0 to 1 ft bgs.

Table 1.9. Outfall 008 – Comparison of analyte detections in sediment and soil to child recreator action levels

Analytical Group	Analyte	Units	Maximum Detect	Industrial Worker Action Level[a]	Child Recreator Action Level	FOD above Industrial Worker Action Level (all samples)[b]	FOD above Child Recreator Action Level (all samples)[b]	FOD above Child Recreator Action Level (only samples outside of security fence)[c]	Notes
DVFURA	2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	0.00143	6.19E-04	4.15E-04	1/7	1/7	010	Location of sample with maximum detect (H050 - SWMU 1) was excavated during the WAG 23 Removal Action (January 1998).
PCBs	PCB-1242	mg/kg	38	4.25E+01	2.83E+01	0/162	1/162	0/21	
PCBs	PCB-1248	mg/kg	35	4.25E+01	2.83E+01	0/160	1/160	0121	
PCBs	PCB-1254	mg/kg	143	1.82E+01	7.81E+00	2/167	2/167	0122	
PCBs	Polychlorinated biphenyl	mg/kg	143	4.25E+01	2.83E+01	1/56	1/56	0/13	
SVOAs	Benzo(a)pyrene	mg/kg	16	2.08E+01	1.46E+01	0/77	1/77	0/4	

[a] IW Action Levels are provided for information only
[b] Considers all sediment/soil samples within the watershed of the outfall, including those within the PGDP security fence and those outside the security fence.
[c] Considers only those sediment/soil samples within the watershed of the outfall that are located outside of the PGDP security fence.

exceeded human health action levels (1×10^{-4}) for a child recreator. No surface water samples exceeded these action levels. Figure 1.16 shows the SWMUs present within the outfall watershed and the location of any surface water or soil samples that exceeded the human health action levels (1×10^{-4}) for a child recreator.

Initial reviews of contaminant concentrations detected in soil (Condition 1) within the watershed indicated that five organics [PCB-1242, PCB-1248, PCB-1254, total PCBs, and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)] and one semivolatile [benzo(a)pyrene] were present in soil sampled from the watershed at concentrations that exceeded the child recreator action level. Further review of these samples showed that the 2,3,7,8-tetrachlorodibenzo-p-dioxin exceedance was located in an area excavated during the WAG 23 Removal Action in January 1998 and is no longer a sample of concern within the watershed. However, since PCB and semivolatile concentrations still are present in excess of the child recreator action level, the SWSC PCT determined that action to contain potential contaminant discharge from Outfall 008 is necessary.

Contaminant concentrations in surface water (Condition 2) for Outfall 008 also were compared to the human health action levels (1×10^{-4}) for a child recreator. No exceedances of this action level were present.

Review of the remediation planned (Condition 3) for SWMUs located in the watershed of Outfall 008 indicated that no remedial actions are scheduled to occur within the next two years. However, although the WAG 23 Removal Action addressed PCB contamination at SWMU 001 (C-747-C Oil Land Farm), it is currently uncertain whether or not SWMU 001 presents a continuing source of PCBs to Outfall 008. Due to this uncertainty, the SWSC PCT determined that action to contain potential contaminant discharge from Outfall **008** is necessary.

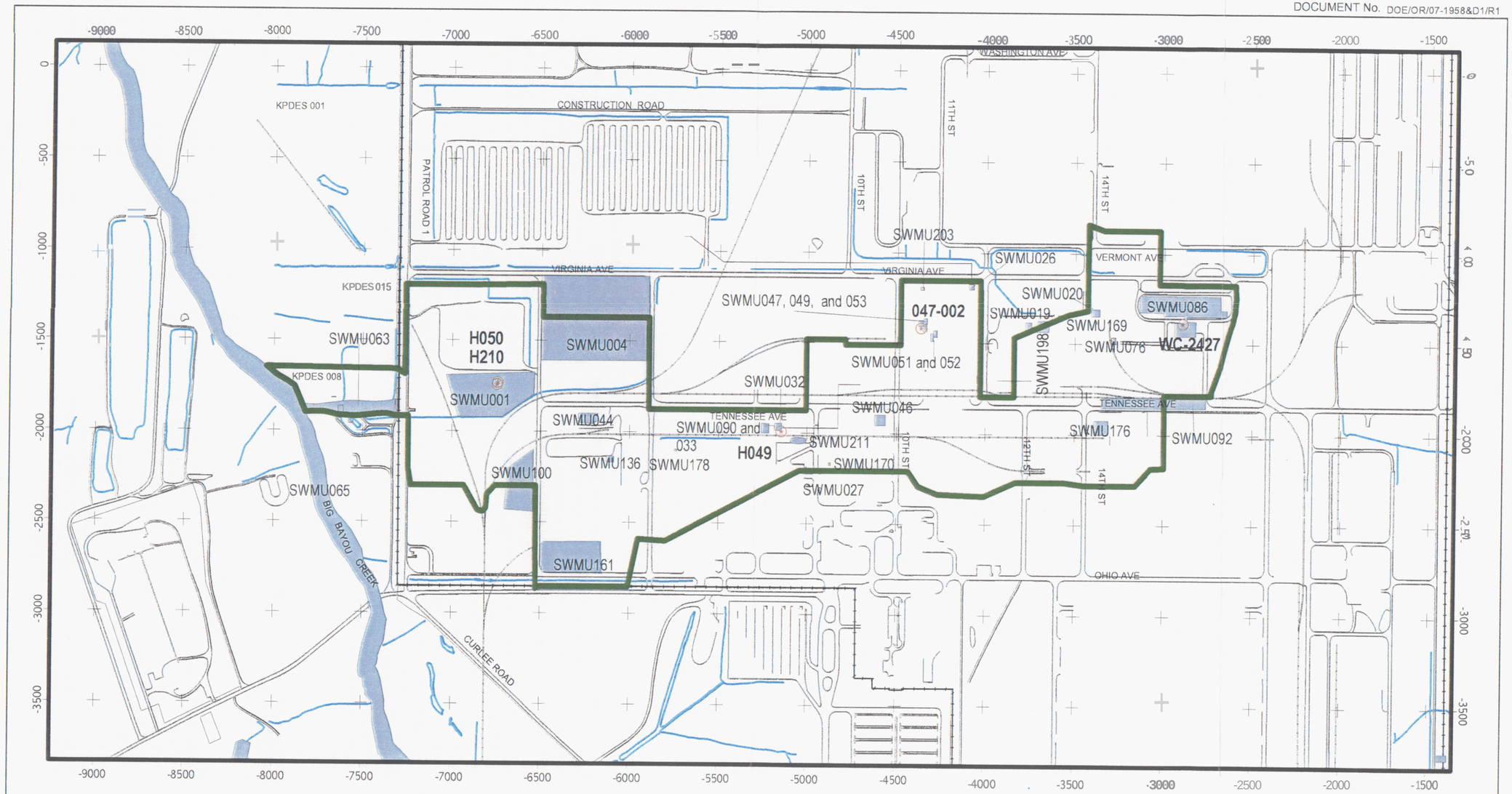
Based on their review of the available data from Outfall 008, the SWSC PCT developed the probable technical responses listed in Table 1.10. The identified uncertainties associated with these probable responses are listed below.

- Future construction or remediation activities could create the opportunity for sediment and contaminated sediment to be mobilized and transported to Bayou Creek.
- Uncertainties as to levels of dissolved phase metals and radionuclides being discharged during storm flow events.
- Contribution and nature of process water is uncertain during normal operations and storm events.

Based on their assessment of the data from Outfall 008, the SWSC PCT determined that Conditions 1 and 3 were present. Therefore, the outfall was binned into Category 1 (action required).

1.5.1.3 Outfall 010

Figure 1.17 shows the watershed for Outfall 010 and all sampling points retained within the binning dataset for consideration by the SWSC PCT. Table 1.11 summarizes the analytical information contained in the binning dataset for Outfall 010. None of the soil/sediment samples from this dataset exceeded the human health action levels (1×10^{-4}) for a child recreator and no surface water samples exceeded these action levels. Figure 1.18 shows the SWMUs present within the outfall watershed and the location of any surface water or soil samples that exceeded the human health action levels (1×10^{-4}) for a child recreator.



LEGEND
Road
Railroad
Stream
SWMU

Watershed 008 Boundary
Soil exceedances of 10e-4 for child recreator
Note: Surface water samples did not exceed the child recreator action level

700 0 700 Feet

TRUE NORTH 28 PLANT NORTH

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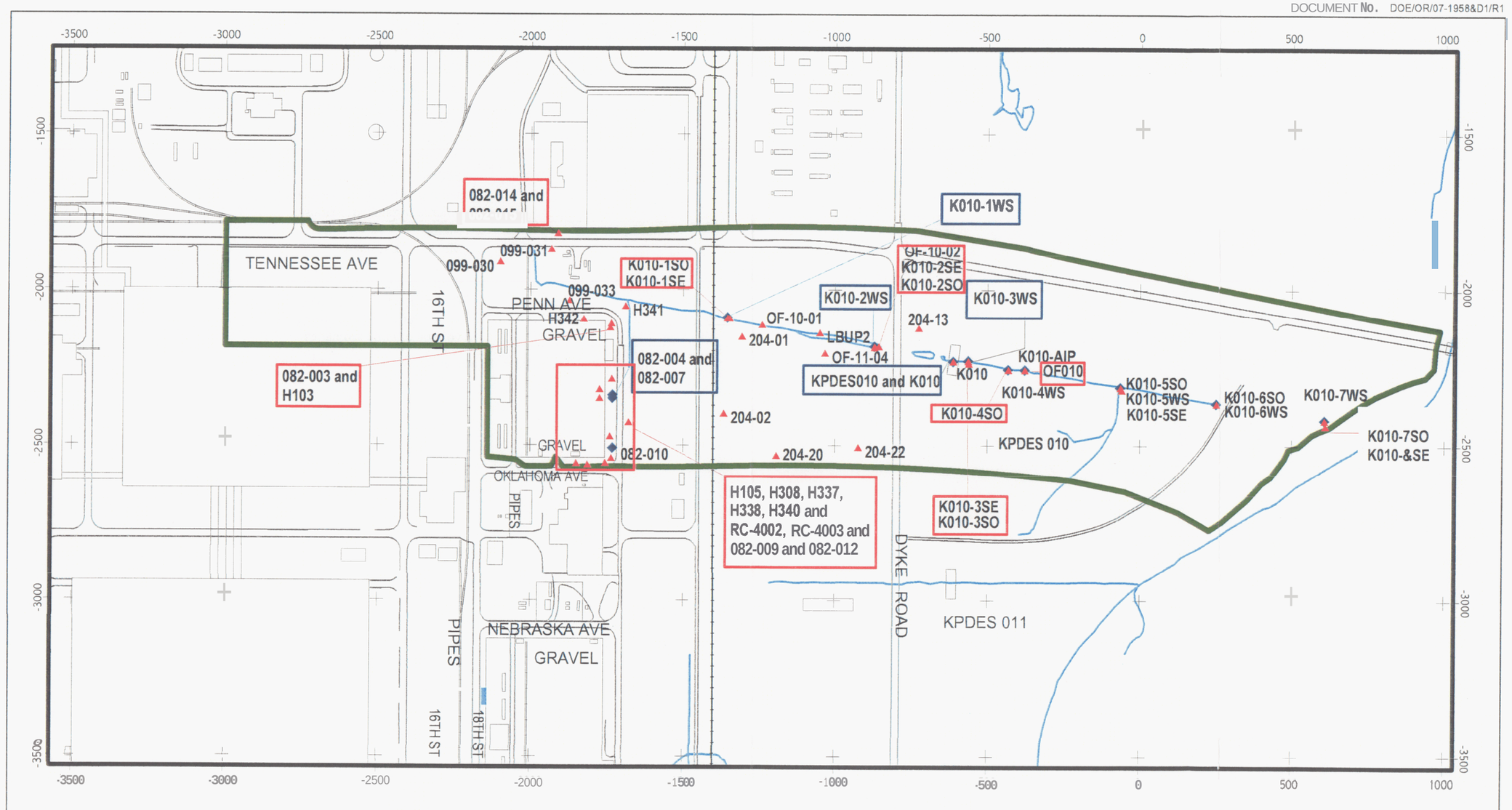
FIGURE No. c5ac90001sk175.apr
DATE 01-22-02

Fig. 1.16 SWMU locations and exceedances of the child recreator action level within Outfall 008 watershed.

Table 1.10. Outfall 008 Technical Approach

Conditions requiring response	Problem(s)	Removal Action Objective(s)	Qualitative Level(s) of Certainty	Likely Response Action(s)
1. Existing sediment contamination	PCB levels in sediment/soil within Outfall 008 exceed the 10(-4) child recreator action level and have the potential to be discharged via storm-flow to Bayou Creek. Currently a TMDL is being considered for Bayou Creek that would establish a PCB Total Maximum Daily Load limit of 0 ppb PCB discharge. (Note: The TMDL is expressed as a goal and is not equivalent to an NPDES permitted limit). In addition the Division of Water is considering posting Bayou Creek for PCB contamination.	Prevent discharge of contaminated sediments/ soil from outfall to Bayou Creek. Minimize sediment/soil discharge from the outfall.	High level of certainty the sediment/soil is contaminated with PCBs. Moderate level of certainty that PCB- contaminated sediment/soil is being transported and discharged through the outfall during storm events. (However, KPDES monitoring does not indicate PCBs are being discharged through the outfall.)	Containment through a combination of systems and/or integrated controls (meet the 30/60 discharge limit up to a 10 year, 24 hour storm event).
2. Existing discharge of contaminated sediment or dissolved phase contamination	None Identified	None Required	Low level of certainty of dissolved contaminant discharge from outfall.	Monitoring during storm flow to determine if dissolved phase contaminants (i.e., metals) are discharged.
3. Future potential for discharge of contaminated sediment or dissolved phase contamination	Existing upgradient contamination and/or near-term remediation of upgradient SWMUs may result in mobilization and discharge of contaminated sediments/soil and dissolved phase contaminants. Uncertainty: See uncertainties listed in Section 1.5.1.2.	Prevent discharge of contaminated sediments/ soils from outfall to Bayou Creek. Minimize sediment/soil discharge from the outfall. Develop design of containment system that is not incompatible with treatment of dissolved phase contaminants of concern.	High level of certainty that Buildings 410 and 420 (when D&D'd) may contribute contaminated sediment/soil to outfall. Low level of certainty that SWMU 001 is currently contributing contaminated sediment/soil to Outfall 008.	Implementation of localized controls during upgradient response actions. Containment through a combination of systems and/or integrated controls (meet the 30/60 sediment discharge limit up to a 10 year, 24 hour storm event). Minimize process water inflows to the sediment control system to the extent practicable.



LEGEND
- Railroad
- Road
- Stream
- Watershed 010 Boundary
- Surface Water Sampling Station
- Soil and Sediment Sampling Station 0 to 1 foot bgs

700 0 700 Feet

TRUE NORTH 20 PLANT NORTH

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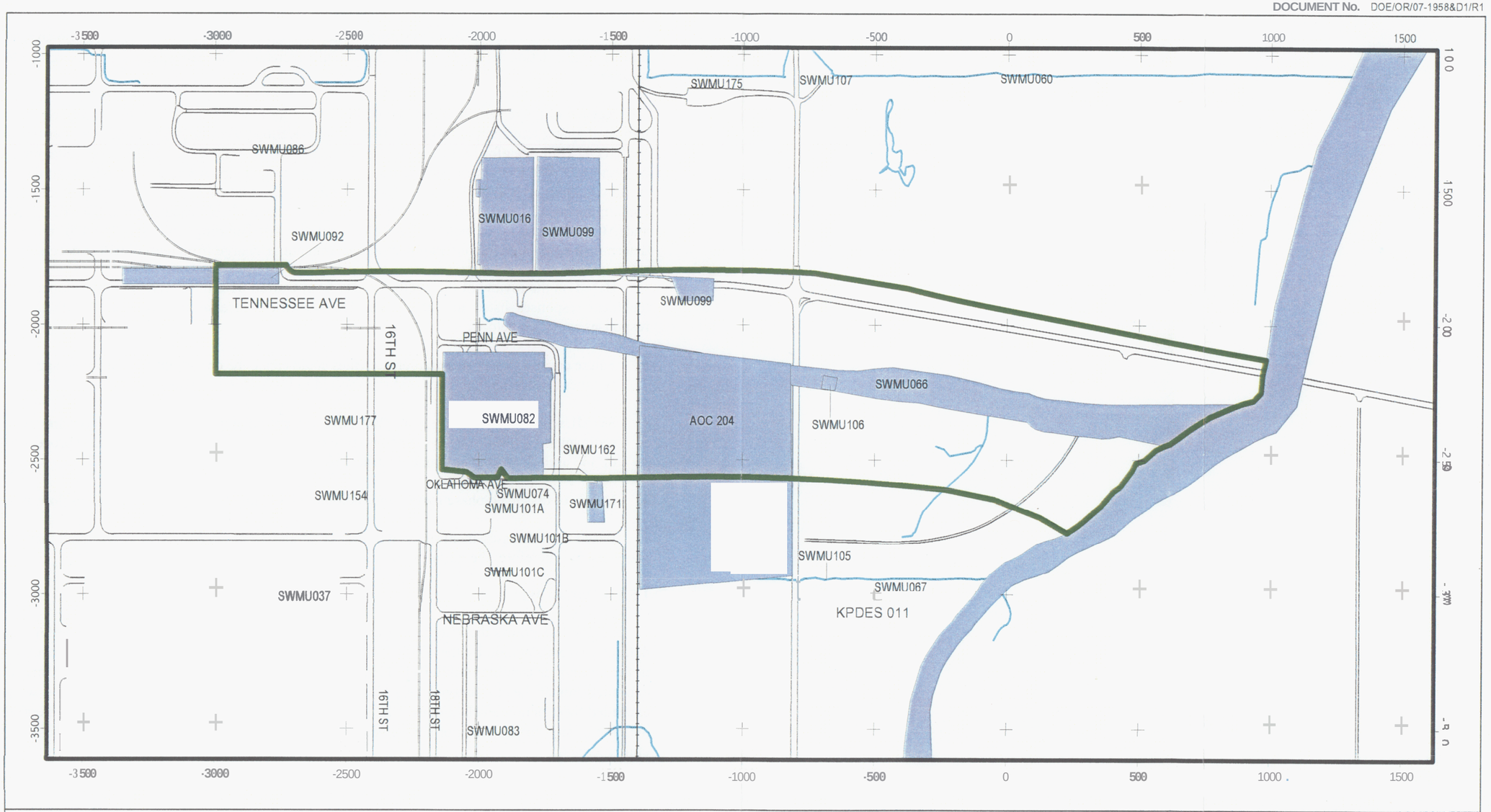
FIGURE No. c5ac90001sk176.apr
DATE 01-22-02

Fig. 1.17 Sampling locations within Outfall 010 watershed.

Table 1.11. Summary of dataset for Outfall 010

Environmental Media	Analytical Group Tested	Number of Samples Tested
Sediment	Metals	8
	PCBs	13
	Radionuclides	9
	semivolatile organic aromatics	1
	volatile organic aromatics	4
Soil[a]	Dioxin/furans	5
	Metals	25
	PCBs	45
	Radionuclides	22
	semivolatile organic aromatics	7
	volatile organic aromatics	5
Surface Water	Metal	19
	Metals – Dissolved	5
	PCBs	5
	Radionuclides	22
	Radionuclides – Dissolved	5
	semivolatile organic aromatics	3
	volatile organic aromatics	5

[a] All soil samples included in the dataset were collected from 0 to 1 ft bgs.



LEGEND

Roads
Railroad Tracks
streams

Watershed 011 Boundary
Swmu noplumes.shp

700 0 700 Feet

TRUE NORTH 20 PLANT NORTH

Note: Neither soil and sediment nor surface water samples exceeded the child recreator action level

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Fig. 1.18 SWMU locations and exceedances of the child recreator action level within Outfall 010 watershed.

FIGURE No. c5ac90001sk252.apr
DATE 01-22-02

Contaminant concentrations in soils (Condition 1) were compared to the human health action levels (1×10^{-4}) for a child recreator and no exceedances were present.

Contaminant concentrations in surface water (Condition 2) for Outfall 010 were also compared to the human health action levels (1×10^{-4}) for a child recreator. No exceedances of this action level were present.

Review of the remediation planned (Condition 3) for SWMUs located in the watershed of Outfall 010 indicated that excavation of SWMU 099 (C-745 Kellogg Building Site) and hot spot excavation at SWMU 92 (Fill Area for Dirt from the C-420) and AOC 204 (Dykes Road Historical Staging Area) may be performed within the next two years. In addition, Decontamination and Decommissioning (D&D) of Buildings 340 and 410/420, if performed during the next two years, could provide a source of contaminated soil for transport via Outfall 010. Due to the probable excavation at SWMU 92, SWMU 99, and AOC 204 and to the potential for D&D activities at Buildings 340 and 410/420, the SWSC PCT determined that action to contain potential contaminant discharge from Outfall 010 is necessary.

Based on the review of the available data from Outfall 010, the SWSC PCT developed the probable technical responses listed in Table 1.12. The identified uncertainties associated with these probable responses are listed below.

- Future construction or remediation activities could create the opportunity for sediment and contaminated sediment/soil to be mobilized and transported to Little Bayou Creek.

- SWMUs 082, 092, 099 & AOC 204 have the potential for future remediation and contaminated sediments/soils would have the potential to be mobilized during that event. D&D process of portions of 340 and 410/420 may impact Outfall 010.

- Levels of dissolved phase metals and radionuclides being discharged during storm flow events.

Based on their assessment of the data from Outfall 010, the SWSC PCT determined that Condition 3 was present. Therefore, the outfall was binned into Category 1 (action required).

1.5.1.4 Outfall 011

Figure 1.19 shows the watershed for Outfall 011 and all sampling points retained within the binning dataset for consideration by the SWSC PCT. Table 1.13 summarizes the analytical information contained in the binning dataset for Outfall 011. Table 1.14 summarizes soil/sediment samples from this dataset that exceeded human health action levels (1×10^{-4}) for a child recreator. Only one surface water sample exceeded these action levels. Figure 1.20 shows the SWMUs present within the outfall watershed and the location of any surface water or soil samples that exceeded the human health action levels (1×10^{-4}) for a child recreator.

Table 1.12. Outfall 010 Technical Approach

Conditions Requiring Response	Problem	Removal Action Objective(s)	Quality Level(s) of Certainty	Likely Response Action(s)
1. Existing sediment contamination	None Identified	Prevent discharge of contaminated sediments/soils from outfall to Little Bayou Creek Minimize sediment discharge from the outfall.	High level of certainty that historical discharge of process water has resulted in sediment/soil contamination within the outfall and upgradient to Little Bayou Creek. However exceedances above acceptable child recreator action levels have not been identified. Low level of certainty that sediment/soil problem warrants early action based on quantitative data.	Monitoring as a part of the SWOU, and any action taken as a result of containing sediment discharge from upgradient SWMUs.
2. Existing discharge of contaminated sediment or dissolved phase contamination	None Identified	None Required	Low level of certainty of dissolved contaminant discharge from outfall.	Monitoring during storm flow to determine if dissolved phase contaminants (i.e., metals) are discharged.
3. Future potential for discharge of contaminated sediment or dissolved phase contamination	Existing upgradient contamination and/or near-term remediation of upgradient SWMUs may result in mobilization and discharge of contaminated sediments/soils and dissolved phase contaminants. Uncertainty: See uncertainties listed in Section 1.5.1.3.	Prevent discharge of contaminated sediments/soils from outfall to Little Bayou Creek. Minimize sediment/soils discharge from the outfall. If a system control is required, develop design of containment system that is not incompatible with treatment of dissolved phase contaminants of concern.	High level of certainty that future remedial actions at SWMU 099 will contribute contaminated sediment/soils to the ditches. Low level of certainty that future remedial actions at SWMU 092 and AOC 204 will contribute contaminated sediment/soils to outfall 010 due to excavation of limited hot spots only. Moderate level of certainty that future D&D activities at 410/420 will contribute sediment/soil to ditches due to only portions of these buildings being included in the Outfall 010 watershed. Low level of certainty that SWMU 082 has the potential to contribute contaminated sediment/soil to ditch during RI activities until D&D activities in approx. 2010. Low level of certainty that existing SWMUs are contributing contaminated sediments/soils during storm water runoff.	Implementation of localized controls during upgradient response actions. Containment through integrated controls to meet the 30/60 sediment and contaminant discharge limit up to a 10 year, 24 hour storm event. Containment through system controls integrated with adjacent outfalls.

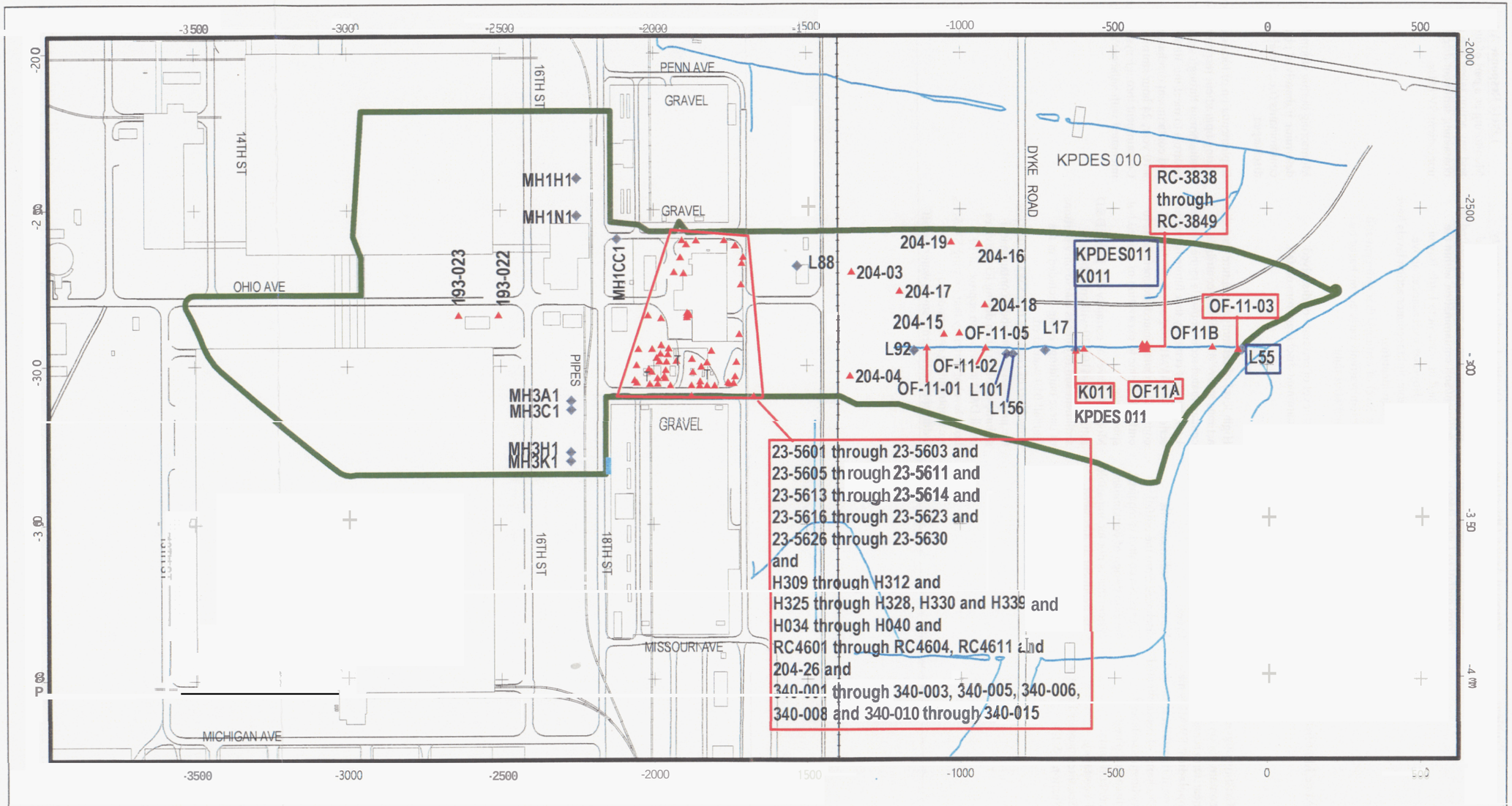


Fig. 1.19 Sampling locations within Outfall 011 watershed.

Table 1.13. Summary of dataset for of Outfall 011

Environmental Media	Analytical Group Tested	Number of Samples Tested
Sediment	Metals	4
	PCBs	20
	Radionuclides	4
	semivolatile organic aromatics	2
	volatile organic aromatics	6
	Dioxin/furans	11
Soil"	Metals	34
	PCBs	145
	Radionuclides	69
	semivolatile organic aromatics	16
	volatile organic aromatics	70
Surface Water	Metals	523
	Metals – Dissolved	1
	PCBs	280
	Radionuclides	380
	Radionuclides – Dissolved	1
	semivolatile organic aromatics	7
	volatile organic aromatics	176

[a] All soil samples included in the dataset were collected from 0 to 1 ft bgs.

Table 1.14. Outfall 011 – Comparison of analyte detections in sediment and soil to child recreator action levels

Analytical Group	Analyte	Units	Maximum Detect	Industrial Worker Action Level'	Child Recreator Action Level	FOD above Industrial Worker Action Level (all samples)[b]	FOD above Child Recreator Action Level (all samples)[b]	FOD above Child Recreator Action Level (only samples outside of security fence)'
PCBs	PCB-1248	mg/kg	1076.381	4.25E+01	2.83E+01	4171	5171	019
PCBs	PCB-1254	mgikg	83.6	1.82E+01	7.81E+00	1/144	2/144	0174
PCBs	PCB-1260	mgikg	475	4.25E+01	2.83E+01	5/145	5/145	0/75
PCBs	Polychlorinated biphenyl	mg/kg	40	4.25E+01	2.83E+01	0/38	1/38	1/31
DYFURA	Pentachloro-dibenzo[b,e][1,4]dioxin	mgikg	0.024	1.24E-03	8.29E-04	1/6	1/6	010
Radionuclides	Protactinium-234m	pCi/g	5000	5.41E+02	1.12E+03	3/15	2115	0/0
Radionuclides	Uranium-238	pCi/g	2740	3.13E+02	6.60E+02	3111	2111	0/2
SVOAs	Benzo(a)pyrene	mgikg	113	2.08E+01	1.46E+01	5/18	6118	0/4
SVOAs	Dibenz(a,h)anthracene	mgikg	71	2.08E+01	1.46E+01	2118	2/18	012

[a] IW Action Levels are provided for information only
[b] Considers all sediment/soil samples within the watershed of the outfall, including those within the PGDP security fence and those outside the security fence.
[c] Considers only those sediment/soil samples within the watershed of the outfall that are located outside of the PGDP security fence.

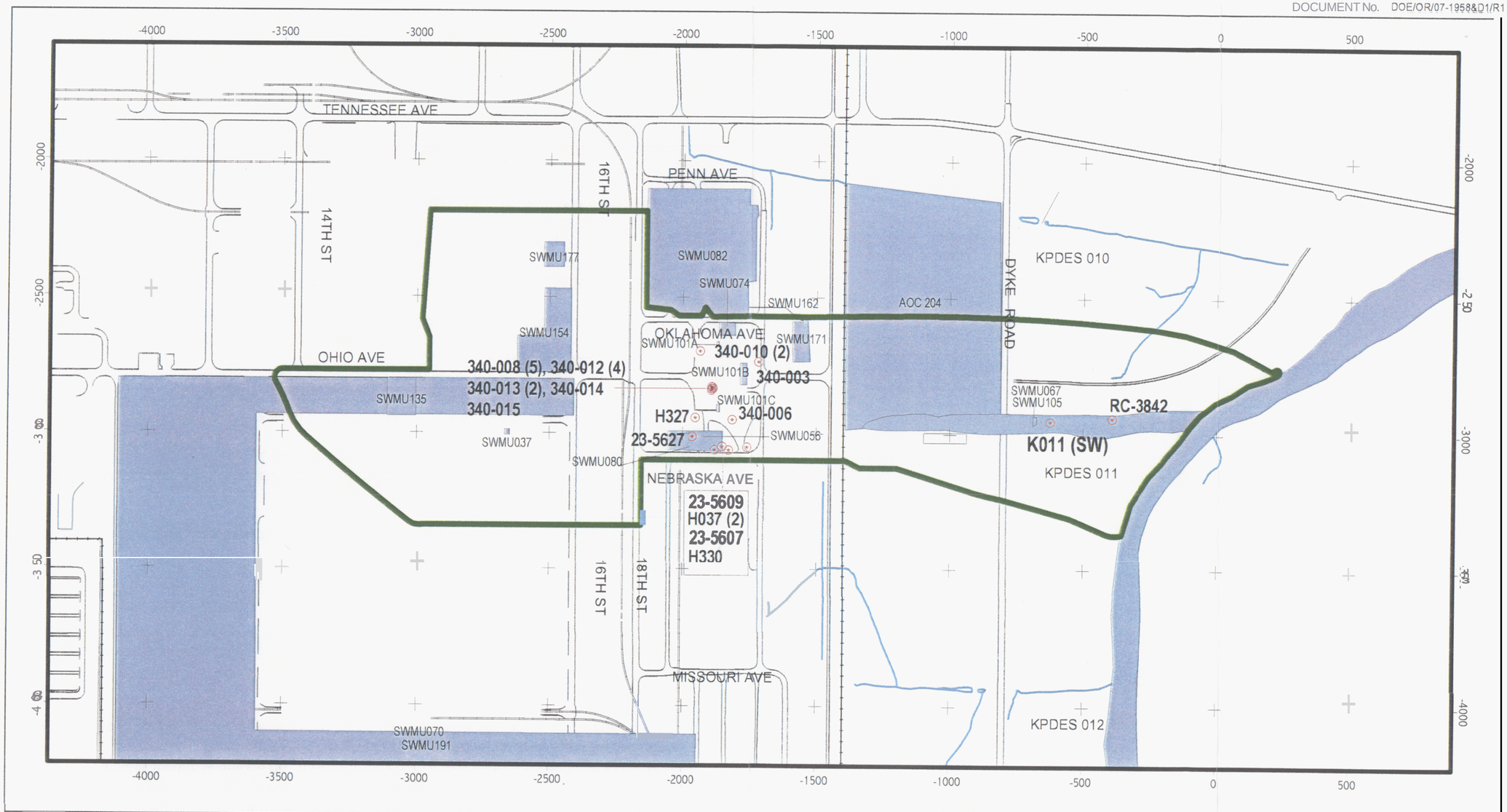


Fig. 1.20 SWMU locations and exceedances of the child recreator action level within Outfall 011 watershed.

FIGURE No. c5ac90001sk178.apr
DATE 01-22-02

Initial reviews of contaminant concentrations detected in soil (Condition 1) within the watershed indicated that five organics [PCB-1248, PCB-1254, PCB-1260, total PCBs, and pentacholor-dibenzo(b,e)(1,4)dioxin (PCDD)], two semivolatiles [benzo(a)pyrene and dibenz(a,h)anthracene], and two radionuclides (proactinium-234m and uranium-238) were present in soil sampled from the watershed at concentrations that exceeded the child recreator action levels. Due to these exceedances, the **SWSC** PCT determined that action to contain potential contaminant discharge from Outfall 011 is necessary.

Contaminant concentrations in surface water (Condition **2)** for Outfall 011 also were compared to the human health action levels (1×10^{-4}) for a child recreator. One metal (lead) was present in concentrations that exceeded the child recreator action level.

Review of the remediation planned (Condition 3) for SWMUs located in the watershed of Outfall 011 indicated that excavation of SWMUs 67 [C-375-E4 Effluent Ditch (C-340 Ditch)], 74 (C-340 PCB Spill Site), 135 [C-333 PCB Soil Contamination (North Side of C-333)], and 154 [C-331 PCB Contamination (Southeast side)] may occur within the next two years. The remediation of these SWMUs potentially may result in the mobilization and transport of contaminated soil/sediment to Little Bayou Creek. The SWSC PCT, therefore, determined that action to contain potential contaminant discharge from Outfall 011 is necessary.

Based on their review of the available data from Outfall 011, the SWSC PCT developed the probable technical responses listed in Table 1.15. The identified uncertainties associated with these probable responses are listed below.

- Future construction or remediation activities could create the opportunity for sediment/soil and contaminated sediment/soil to be mobilized and transported to Little Bayou Creek.
- Under existing conditions, some **PCB** contaminated **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.
- Levels of dissolved **phase** metals and radionuclides being discharged from Outfall 011 during storm flow.
- Contribution and nature of process water is uncertain during storm events. It is uncertain whether or not this contribution can be evaluated and addressed efficiently.

Based on the assessment of the data from Outfall 011, the SWSC PCT determined that Conditions 1, 2, and 3 were present. Therefore, the outfall was binned into Category 1 (action required).

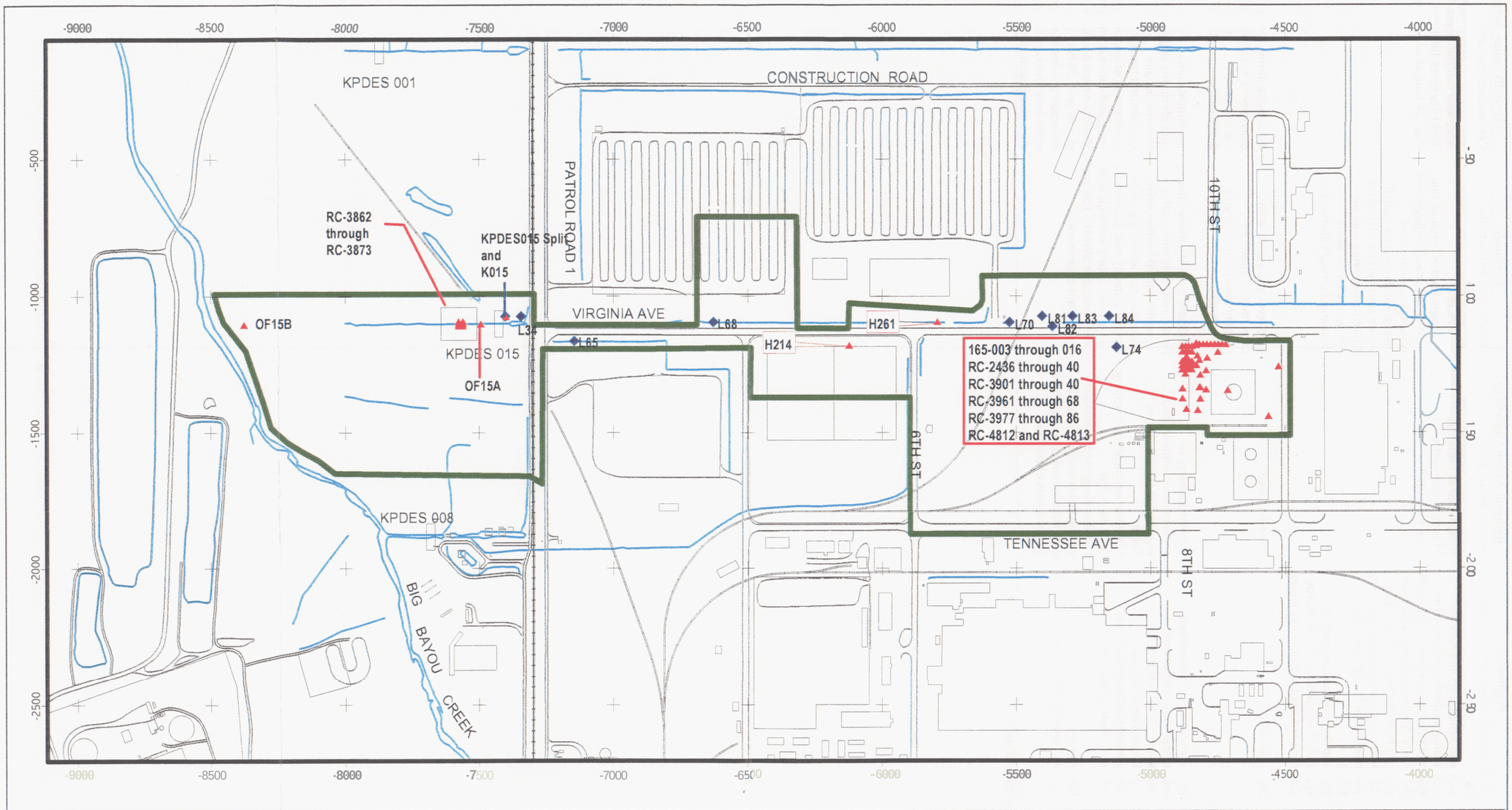
1.5.1.5 Outfall 015

Figure 1.21 shows the watershed for Outfall 015 and all sampling points retained within the binning dataset for consideration by the **SWSC** PCT. Table 1.16 summarizes the analytical information contained in the binning dataset for Outfall 015. Table 1.17 summarizes soil/sediment samples that exceeded human health action levels (1×10^{-4}) for a child recreator. No surface water samples exceeded these action levels. Figure 1.22 shows the SWMUs present within the outfall watershed and the location of any surface water or soil samples that exceeded the human health action levels (1×10^{-4}) for a child recreator.

Table 1.15. Outfall 011 Technical Approach

Conditions requiring response	Problem(s)	Removal Action Objective(s)	Qualitative Level(s) of Certainty	Likely Response Action(s)
1. Existing sediment contamination	PCB levels in sediment/soil[a] within Outfall 011 exceed the 10(-4) child recreator action level and have the potential to be discharged via storm-flow to Little Bayou Creek violating the PCB Total Maximum Daily Load limit of 0 ppb PCB discharge. (Note: The TMDL is expressed as a goal and is not equivalent to an NPDES permitted limit). Radionuclides in sediment/soil in Outfall 011 upgradient of Little Bayou Creek exceed child recreator risk levels	Prevent discharge of contaminated sediments/soils from outfall to Little Bayou Creek Minimize sediment/soil discharge from the outfall.	High level of certainty the sediment/soil is contaminated with PCBs. Moderate level of certainty that PCB contaminated sediment/soil is being transported and discharged through the outfall during storm events. (However, KPDES monitoring does not indicate PCBs are being discharged through the outfall.)	Containment through a combination of systems and/or integrated controls (meet the 30/60 discharge limit up to a 10 year, 24-hour storm event).
2. Existing discharge of contaminated sediment or dissolved phase contamination	None Identified	None Required	Low level of certainty with magnitude of dissolved contaminants being discharge from outfall.	Monitoring during storm events to determine if dissolved phase contaminants (i.e., metals) are discharged from Outfall 011.
3. Future potential for discharge of contaminated sediment or dissolved phase contamination	.Existing upgradient contamination and/or near-term remediation of upgradient SWMUs may result in mobilization and discharge of contaminated sediments/soils and dissolved phase contaminants. Uncertainty: See uncertainties listed in Section 1.5.1.4.	Prevent discharge of contaminated sediments/soils from outfall to Little Bayou Creek. Minimize sediment/soil discharge from the outfall. Develop design of containment system that is not incompatible with treatment of dissolved phase contaminants of concern.	Moderate level of certainty that contaminated sediment/soil is being discharged for the outfall watershed as a whole (e.g., high level of certainty that Building C-340 **is** contributing and high level of certainty that SWMUs **056** and 080 **are not** contributing).	Implementation of localized controls during upgradient response actions. Containment through a combination of systems and/or integrated controls (meet the 30/60 sediment discharge limit up to a 10 year, **24** hour storm event). Minimize process water inflows to the sediment control system to the extent practicable.

[a] Refers to all soils available for transport.



LEGEND

- Railroad
- Road
- Stream
- Watershed 015 Boundary
- Surface Water Sampling Station
- Soil and Sediment Sampling Station 0 to 1 foot bgs

700 0 700 Feet

TRUE NORTH 20 PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

FIGURE No. c5ac90001sk179.apr
DATE 01-22-02

Fig. 1.21 Sampling locations within Outfall 015 watershed.

Table 1.16. Summary of dataset for Outfall 015

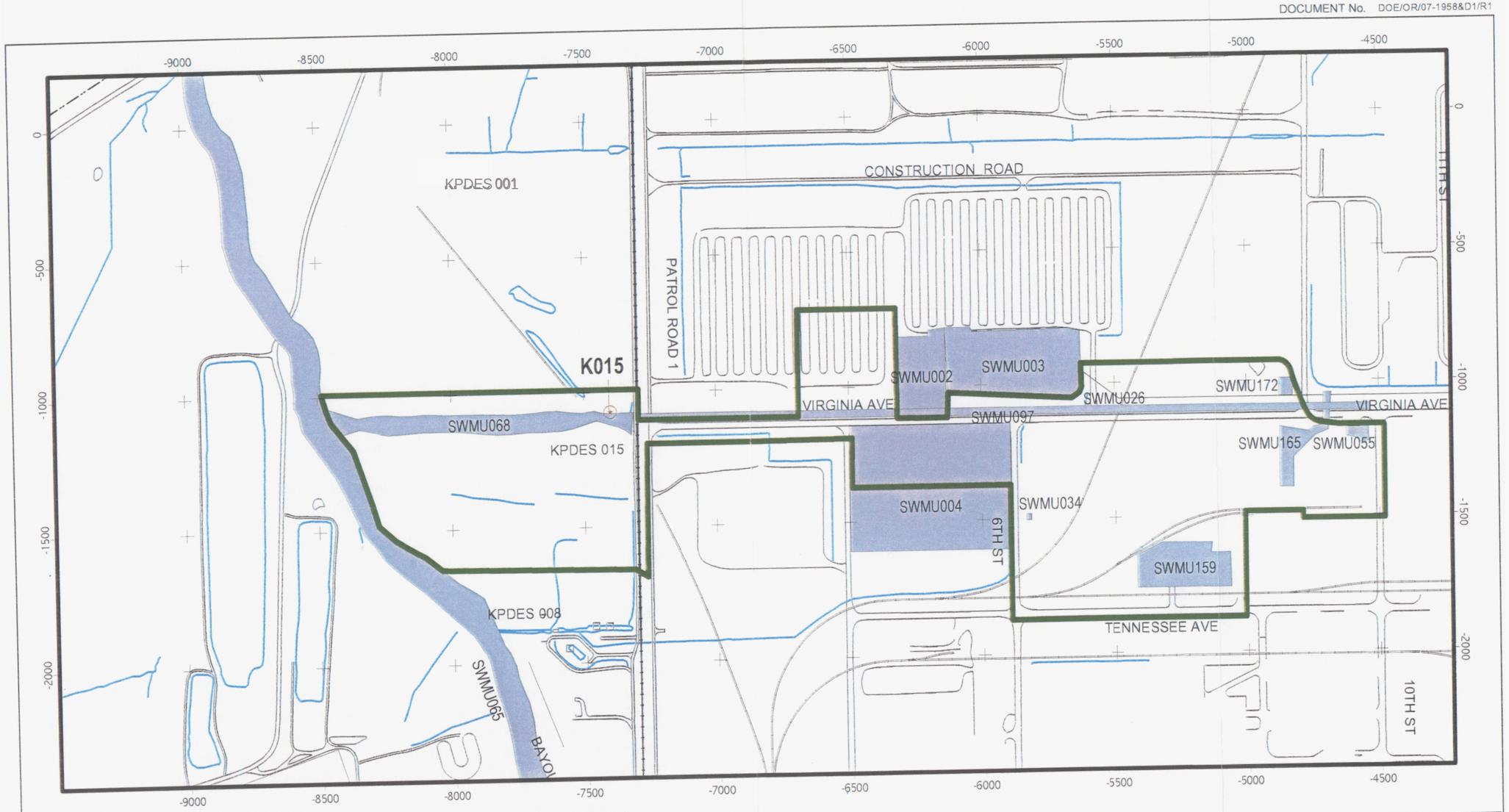
Environmental Media	Analytical Group Tested	Number of Samples Tested
Sediment	Metals	3
	PCBs	**4**
	Radionuclides	3
	semivolatile organic aromatics	2
	volatile organic aromatics	**2**
Soil[a]	Dioxin/furans	**0**
	Metals	**26**
	PCBs	**86**
	Radionuclides	32
	semivolatile organic aromatics	9
	volatile organic aromatics	**4**
Surface Water	Metals	157
	Metals – Dissolved	**2**
	PCBs	**113**
	Radionuclides	**95**
	Radionuclides – Dissolved	**2**
	semivolatile organic aromatics	**6**
	volatile organic aromatics	61

[a] All soil samples included in the dataset were collected from 0 to 1 ft bgs.

Table 1.17. Outfall 015 – Comparison of analyte detections in sediment and soil to child recreator action levels

Analytical Group	Analyte	Units	Maximum Detect	Industrial Worker Action Level[a]	Child Recreator Action Level	FOD above Industrial Worker Action Level (all samples)[b]	FOD above Child Recreator Action Level (all samples)[b]	FOD above Child Recreator Action Level (only samples outside of security fence)[c]	Notes
Radionuclides	Cesium-137	pCi/g	52.3	1.05E+01	2.18E+01	1/4	1/4	1/2	Location of sample exceeding action levels (K015 collected 9/99) is within Outfall 015 adjacent to the Oil Water Control Dam.

[a] IW Action Levels are provided for information only.
[b] Considers all sediment/soil samples within the watershed of the outfall, including those within the PGDP security fence and those outside the security fence.
[c] Considers only those sediment/soil samples within the watershed of the outfall that are located outside of the PGDP security fence.



LEGEND
- Railroad
- Road
- Stream
- Watershed 015 Boundary
- Soil exceedances of 10e-4 for child recreator
- SWMU locations

Note: Surface water samples did not exceed the child recreator action level

700 0 700 Feet

TRUE NORTH 28 PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

SAIC
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Oak Ridge, Tennessee 37831

FIGURE No. c5ac90001sk180.apr
DATE 01-22-02

Fig. 1.22 SWMU locations and exceedances of the child recreator action level within Outfall 015 watershed.

Initial reviews of contaminant concentrations detected in soil (Condition 1) within the watershed indicated that one radionuclide (cesium-137) was present in soil sampled from the watershed at concentrations that exceeded the human health action levels (1×10^{-4}) for a child recreator. Due to these exceedances, the SWSC PCT determined that action to contain potential contaminant discharge from Outfall 015 is necessary.

Contaminant concentrations in surface water (Condition 2) for Outfall 015 also were compared to the human health action levels (1×10^{-4}) for a child recreator. No exceedances of this action level were present.

Review of the remediation planned (Condition 3) for SWMUs located in the watershed of Outfall 015 indicated that excavation of SWMUs 2 (C-749 Uranium Burial Ground), 3 (C-404 Low-Level Radioactive Waste Burial Ground), and 4 (C-747 Burial Ground) may occur within the next two years. The remediation of these SWMUs potentially may result in the mobilization and transport of contaminated soil/sediment to Bayou Creek. The SWSC PCT, therefore, determined that action to contain potential contaminant discharge from Outfall 015 is necessary.

Based on the review of the available data from Outfall 015, the SWSC PCT developed the probable technical responses listed in Table 1.18. The identified uncertainties associated with these probable responses are listed below.

- Future construction or remediation activities could create the opportunity for sediment/soil and contaminated sediment/soil to be mobilized and transported to Bayou Creek.
- Levels of dissolved phase radionuclides being discharged during storm flow events.
- SWMUs 002, 003, and 004 have the potential for future remediation, and contaminated sediments/soils would have the potential to be mobilized during those events.

Based on the assessment of the data from Outfall 015, the SWSC PCT determined that Conditions 1 and 3 were present. Therefore, the outfall was binned into Category 1 (action required).

1.6 STREAMLINED RISK EVALUATION

As discussed in Section 1.5, Source, Nature, and Extent of Contamination, a concern exists that particulate matter and associated contaminants, such as PCBs, radionuclides, and metals, potentially are transported in ditches leading from the PGDP to Outfalls 001, 008, 010, 011, and 015 and potentially discharged to Little Bayou Creek or Bayou Creek. Risk has been identified for both human and ecological receptors potentially exposed to contaminated sediments and surface water containing dissolved and suspended contaminants. The existing level of risk to humans has been mitigated through the use of access restrictions such as manned patrols, signs, and fences that are currently in place.

Hazardous substances historically detected in sediments and surface water at Outfalls 001, 008, 010, 011, and 015 and that are potentially posing unacceptable risk to human health and the environment are identified in the following two sections. In addition to concerns regarding the presence of contaminants in sediment and surface water, there also is concern that total suspended solids (TSS) in water being discharged at Outfalls 001, 008, 010, 011, and 015 may impact surface water quality. However, at this time, there are no TSS limits that are accepted and approved by EPA and KDEP that can be used to determine whether or not further action is required to protect ecological receptors or that can be used to make response decisions about TSS levels in discharges to Little Bayou Creek and Bayou Creek from Outfalls 001, 008, 010,011, and 015.

Table 1.18. Outfall 015 Technical Approach

Conditions Requiring Response	Problem(s)	Removal Action Objective(s)	Quality Level(s) of Certainty	Likely Response Action(s)
1. Existing sediment contamination	Historical discharge of process water has resulted in sediment/soil contamination (metal and radionuclide) within the outfall and upgradient to Bayou Creek above acceptable child recreator risk levels.	Prevent discharge of contaminated sediments/soils from outfall to Bayou Creek. Minimize sediment/soil discharge from the outfall.	Low level of certainty that sediment/soil problem warrants early action based on quantitative data.	Monitoring as a part of the SWOU, and any action taken as a result of containing sediment discharge from upgradient SWMUs.
2. Existing discharge of contaminated sediment or dissolved phase contamination	None Identified	None Required	Low level of certainty of dissolved contaminant discharge from outfall.	Monitoring during storm flow to determine if dissolved phase contaminants (i.e., metals) are discharged.
3. Future potential for discharge of contaminated sediment or dissolved phase contamination	Existing upgradient contamination and/or near-term remediation of upgradient SWMUs may result in mobilization and discharge of contaminated sediments/soils and dissolved phase contaminants. Uncertainty: See uncertainties listed in Section 1.5.1.5.	Prevent discharge of contaminated sediments/soils fiom outfall to Bayou Creek. Minimize sediment/soils discharge from the outfall. If a system control is required, develop design of containment system that is not incompatible with treatment of dissolved phase contaminants of concern.	Moderate level of uncertainty as to the level of rad contamination in the ditch. High level of certainty that future remedial actions will contribute contaminated sediment/soil to the ditches.	Implementation of localized controls during upgradient response actions. Containment through integrated controls to meet the 30/60 sediment and contaminant discharge limit up to a 10 year, 24 hour storm event. Containment through system controls integrated with adjacent outfalls.

1.6.1 Human Health Risk

As part of the screening level risk assessment conducted for this EE/CA, concentrations of chemicals and compounds detected historically in surface water and sediment at Outfalls 001, 008, 010, 011, and 015 were compared to no action and action screening values presented in the December 2000 draft of Appendix A in ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant) Paducah, Kentucky)***DOE/OR/07-1506&D1/N1/R0, (DOE 2000a).

The no action values used in these comparisons were risk-based values calculated using either a target cancer risk value of 1×10^{-6} or a target **HI** value of 0.1. The action values used in the comparison for this removal action were risk-based values calculated using either a target cancer risk value of 1×10^{-4} or a target HI value of 3. The cancer **risk** value is the probability of the development of cancer upon exposure to a carcinogen. A cancer risk value of 1×10^{-6} indicates that an individual has a 1 in 1,000,000 chance of developing cancer upon exposure to the carcinogen. The HI is a measure of the potential for development of a systemic toxic effect within an individual upon exposure to a chemical or compound. A HI value below 1 indicates that the development of a toxic effect is unlikely. A value greater than 1 indicates that a toxic effect may occur. The results of all comparisons along with supporting summary statistics are included in the previously referenced "binning packages" (SAIC 2001).

Tables summarizing the results of this screening level risk assessment are presented in Appendix A. Tables A.1 and A.2 present a summary of the chemicals and compounds detected in samples collected from Outfall 001 soils and sediments and in samples collected from Outfall 001 surface water. These tables list the maximum detected concentration for each chemical or compound, the frequency at which each chemical or compound was detected above the industrial worker and child recreational user screening value, and the industrial worker and child recreational user screening values. Tables A.3 through A.10 have similar information for the other outfalls.

Results in Tables **A.**1 through A.10 show that several chemicals and compounds have been detected in the soil, sediment, or surface water of these five outfalls at concentrations exceeding both the no action and the action screening levels. Exceptions are Outfall 001, 008, 010, and 015 surface water and Outfall 010 soil and sediment where no exceedances of the action levels are seen. Additionally, Outfall 011 surface water and Outfall 015 soil and sediment each have only one contaminant with an exceedance of an action level.

Chemicals and compounds that exceed the action screening levels are of special note because the **EPA** specifies that exceedances of these levels must be remediated (require action). At all outfalls, detections at concentrations above the action numbers are infrequent. The chemicals and compounds in soils and sediments at Outfall 001 exceeding the industrial worker and child recreator action levels include several PCB mixtures and radionuclides. The chemicals and compounds in soils and sediments at Outfall 008 exceeding the industrial worker and child recreator action levels include 2,3,7,8-TCDD (i.e., a dioxin), benzo(a)pyrene (i.e., a PAH), and several PCB mixtures. The chemicals and compounds in soils and sediments at Outfall 011 exceeding the industrial worker and child recreator action levels are PAHs, several PCB mixtures, PCDD (i.e., another dioxin), and uranium-238. The only chemical in soil and sediments at Outfall 015 that exceeds the industrial worker and child recreator action levels is cesium-137.

As noted earlier, the only detection in surface water that exceeds an action level is from Outfall 011. The chemical exceeding its action level is lead with a maximum detect of 0.204 mg/L versus an action level of 0.030 mg/L.

The results of the screening risk assessment conducted on historical data from PGDP indicate that action to address the potential migration of contamination in soils and sediments in the outfalls is a conservative approach and is appropriate in order to protect human health. Historically, several chemicals

and compounds were detected in sediments in these outfalls at concentrations exceeding action and no action screening levels.

1.6.2 Ecological Risk

In this section concentrations of potentially hazardous substances in sediment, surface water and soil associated with Outfall 001,008,010,011, and 015 watersheds are compared to effects-based concentrations for ecological receptors. Site concentrations are compared to PGDP No Further Action (NFA) values and PGDP Upper Screening Values (USVs). Tables summarizing these comparisons are provided in Appendix A.

The PGDP NFA values and USVs (Table A.11) are described in the November 2000 draft of ***Methods for Designing and Conducting Ecological Risk Assessments and Risk Evaluations at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). NFA levels for chemical constituents are concentrations in abiotic media used to screen constituents detected at a site to identify those that require further evaluation. NFA levels generally are conservative estimates of chemical concentrations that have a high probability of not adversely affecting ecological receptors. USVs for chemical constituents are concentrations in abiotic media that pose a high probability of adverse effect (risk) to the receptor if the exposure and toxicity assumptions are true. The results of all comparisons, along with supporting summary statistics, are included in the previously referenced "binning packages" (SAIC 2001).

Fourteen metals, acetone, bis(2-ethylhexyl)phthalate, carbon disulfide, eight PAHs and PCBs were detected in Outfall 001 ditch sediment at concentrations exceeding PGDP sediment NFA values for ecological receptors (Table A.12). Table **A.**12 shows that arsenic, nickel, 3 PAHs, and PCBs were detected in Outfall 001 sediment at concentrations exceeding PGDP sediment USVs. Eighteen metals, 2-propanol, bis(2-ethylhexyl)phthalate, and three PCB congeners were detected in Outfall 001 surface water at concentrations exceeding PGDP surface water NFA values for ecological receptors, and eleven metals, including cadmium, copper, lead, and uranium, 2-propanol, and two PCB congeners in outfall 001 surface water exceed PGDP surface water USVs (Table A.13). Twenty metals, nine PAHs, phthalates, pentachlorophenol, and PCBs were detected in Outfall 001 soil at concentrations exceeding PGDP soil NFA values for ecological receptors, and seven metals, nine PAHs, pentachlorophenol, and total PCBs in Outfall 001 surface soil exceeded PGDP soil USVs (Table A.14).

Eleven metals, acetone, bis(2-ethylhexyl)phthalate, three PAHs and PCBs were detected in Outfall 008 ditch sediment at concentrations exceeding ecological PGDP sediment NFA values, and mercury, three PAHs, and PCBs in Outfall 008 sediment exceed USVs (Table A.15). Fifteen metals were detected in Outfall 008 surface water at concentrations exceeding ecological PGDP surface water NFA values, and eight metals, including cadmium, copper, lead, thallium and zinc, in surface water at Outfall 080 exceed surface water USVs (Table A.16). Twenty-one metals, 2,3,7,8-tetrachlorodibenzo-p-dioxin, nine PAHs, phenol, phthalates, TCE, vinyl chloride, total cresols and PCBs were detected in Outfall 008 soil at concentrations exceeding ecological PGDP soil NFA values, and ten metals, 2,3,7,8-tetrachlorodibenzo-p-dioxin, nine PAHs, total PCBs and TCE in Outfall 080 soil exceed PGDP soil USVs (Table A.17).

Eleven metals and tetrachloroethene were detected in Outfall 010 ditch sediment at concentrations exceeding sediment NFA values, but no substances were detected in sediment from Outfall 010 that exceeded PDGP sediment USVs (Table A.18). Fifteen metals and two phthalates were detected in Outfall 010 surface water at concentrations exceeding surface water NFA values, and nine metals, including cadmium, copper, lead, silver and zinc, in surface water at Outfall 010 were detected at concentrations above the USV (Table A.19). Twenty metals and eight PAHs were detected in Outfall 010 soil at concentrations exceeding soil NFA values, and six PAHs and five metals, including cadmium, chromium, and mercury, in Outfall 010 soil exceeded PGDP soil USVs (Table A.20).

Ten metals, PCBs, 13 PAHs, and TCE were detected in Outfall 011 ditch sediment at concentrations exceeding sediment NFA values, and chromium, six PAHs, and PCBs were detected in Outfall 011 ditch sediments at concentrations that exceeded PGDP sediment **USVs** (Table A.21). Twelve metals, sulfide, three PCB congeners, and bis(2-ethylhexyl)phthalate were detected in Outfall 011 surface water at concentrations or activities exceeding surface water NFA values, and aluminum, barium, boron, cadmium, copper, iron, lead, manganese, uranium, zinc and PCBs in surface water at Outfall 011 exceed surface water **USVs** (Table A.22). Nineteen metals, PCBs, nine PAHs, phthalates, TCE, tetrachloroethene, and **two** radionuclides (protactinium-234 and thorium-234) were detected in Outfall 011 soil at concentrations or activities exceeding soil **NFA** values, and seven metals (barium, chromium, copper, mercury, nickel, selenium and uranium), 2,3,7,8-tetrachlorodibenzo-p-dioxin, nine PAHs, and total PCBs in Outfall 011 soil exceed PGDP soil **USVs** (Table A.23).

In Outfall 015 sediment, nine metals, acetone and PCBs were detected at concentrations exceeding sediment NFA values, but only total PCBs were detected at concentrations exceeding sediment **USVs** (Table A.24). Sixteen metals, sulfide, and bis(2-ethylhexyl)phthalate in surface water from Outfall 015 exceeded PGDP surface water **NFA** values, and eleven metals in surface water from Outfall 015 exceeded PGDP **USVs –** aluminum, antimony, barium, boron, cadmium, copper, iron, lead, thallium, uranium, and zinc (Table A.25). Twenty metals, six PAHs, PCBs, and chloroform in soil from Outfall 015 exceeded soil NFA values, and arsenic, barium, cadmium, mercury, nickel, selenium, three PAHs, and total PCBs in soil at Outfall 015 exceed soil **USVs** (Table A.26).

The presence of substances at concentrations exceeding PGDP sediment, surface water, and soil NFA values indicates only that there is a potential for adverse effects on ecological receptors, not that adverse effects did or are expected to occur (DOE 2000b). Exceeding **USVs,** on the other hand, indicates a high probability that the substance will cause adverse effects on ecological receptors exposed directly or indirectly to sediment, surface water, and soil; however, adverse effects may not be realized at the site due to site-specific sediment, surface water, and soil properties that potentially can mitigate exposure and toxicity to biota (DOE 2000b). Some **of** these site-specific properties for sediment and soil include percent organic carbon, percent silt and clay, and pH; some of the site-specific properties for surface water include hardness, alkalinity, pH, temperature, and total organic carbon (TOC). While unlikely, it also is possible that local biotic communities may be tolerant of concentrations equal to or greater than the **USVs.**

An ecological risk assessment utilizing site-specific investigations of biota would be required to confirm or deny whether or not adverse effects have occurred, or are occurring, as a result of exposure to contaminants in the sediment, surface water, or soil associated with Outfall 001, 008, 010, 011, and 015 watersheds. It is possible that releases **of** contaminants from Outfalls **008** and 015 contributed to observed elevated tissue levels in aquatic biota associated with sediments in Bayou Creek. The results of the screening ecological risk assessment indicate that action to address contamination in sediments in Outfalls 001, 008, 010, 011, and 015 is appropriate to protect ecological receptors. Several chemicals and compounds are present in sediment, surface water and soil associated with outfall watersheds at concentrations exceeding no action and "probable effect" screening values.

1.7 COMMUNITY PARTICIPATION

Community involvement is a critical aspect of the CERCLA process. DOE is conducting community relations activities for this project in compliance with 40 CFR 300.415(m)(1), (m)(3), and (m)(4), and the DOE-approved community relations plan, ***Community*** *Relations Plan* ***for*** *the Environmental Management*

and Enrichment Facilities Program, Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE 1998b). Community relations activities related to this removal action will include, but are not limited to, the following:

- development and distribution of fact sheets as needed;
- issuance of press releases, as needed, to local media on the project status;
- hold public meetings, availability sessions, or workshops as deemed necessary;
- distribution of information materials to the established community mail list; and
- involvement of the public in the decision-making process (i.e., issuance of the EE/CA for public review and comment).

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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 and the applicable or relevant and appropriate requirements (ARARs) also are 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. A response under CERCLA is appropriate when (1) hazardous substances or contaminants are released or (2) there is a substantial threat of a release into the environment and response is necessary to protect human health and the environment.

A removal action is warranted for Outfalls 008, 010, 011, 015, and the balance of Outfall 001 when consideration is given to the factors listed in 40 CFR Section 300.415(b)(2). These factors include the following:

- actual or potential exposure to nearby populations, animals, or the food chain from hazardous substances or pollutants or contaminants;
- high levels of hazardous substances or pollutants or contaminants in soils, largely at or near the surface, that may migrate; and
- weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

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 1994) 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 present an evaluation of the need for response actions for site-wide sediment control at PGDP and to evaluate alternatives appropriate for these response actions. This EE/CA evaluates measures to contain/prevent/minimize the potential surface water discharge of contaminated sediment from PGDP to mitigate exposure to potential down-stream receptors and proposes periodic monitoring of the sediment control measures implemented to ensure that the chosen alternatives perform as expected.

A detailed monitoring plan specifying sample location, sampling frequency, and parameters to be monitored is not included in this EE/CA. A detailed monitoring plan will be included in the SWSC RAWP. If monitoring results indicate that treatment is required either for dissolved phase contamination or contaminated sediment in the surface water being discharged from Outfalls 008, 010, 011, 015, or the balance of Outfall 001, a separate CERCLA decision process would be initiated to address this treatment.

2.3 REMOVAL ACTION OBJECTIVES

The RAOs that have been established for the sediment control measures are as follows.

- Prevent discharge of contaminated sediments/soils from the outfalls to Bayou or Little Bayou Creek.
- Minimize sediment discharge from the outfalls.
- If a containment system is required, develop the design of containment system such that it is not incompatible with treatment of dissolved phase contaminants of concern.
- Evaluate minimization of process water inflows to the sediment control system.

2.4 JUSTIFICATION FOR THE PROPOSED ACTION

Outfalls 001, 008, 010, 011, and 015 have been identified as SWMUs **69,** 63, ***66,*** **67,** and **68,** respectively, under the PGDP FFA due to the potential for actual or threatened releases of hazardous substances from the site. While required periodic monitoring indicates that surface water discharge from these outfalls generally are in compliance with KPDES permit limits designated for the operating facilities at PGDP, the parameters monitored under these permits do not address all CERCLA COPCs that may be present within the outfall watersheds. Evaluations of sediment contaminant concentrations and proposed near-term (i.e., within **2** years) remedial actions within the watersheds of these outfalls, indicate that the potential for surface water discharge of these CERCLA COPCs in the form of potentially contaminated sediment and dissolved phase contamination could exist at these outfalls if specific situations were to occur. These situations include excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls); infrequent off-normal conditions, such as maintenance activities, when existing runoff and sediment control measures are inoperable; the remediation of upgradient SWMUs within the watershed that could disturb and mobilize contaminated surface and shallow subsurface soil and, therefore, represent the potential for surface water discharge of contamination; or the occurrence of new upgradient contamination with the potential for off-site transportation via storm runoff. This removal action is intended to contain/prevent/minimize the potential surface water discharge of contaminated sediment from PGDP when existing conditions or future planned activities have the potential to mobilize contaminants that could adversely affect downstream receptors. Additionally, this EE/CA also proposes periodic monitoring of the sediment control measures implemented to ensure that the chosen alternative perform as expected.

2.4.1 Outfall 001

The drainage area associated with the balance of Outfall 001 is approximately 61.7 ha (152.5 acres). Under normal operations, all process water from the East/West Diversion Ditch (i.e., Outfall 001) is lifted to the NSDD and then directed to C-616 Full Flow Lagoon for treatment and eventual discharge downgradient of Outfall 001, to Bayou Creek. Mechanical failure, maintenance activities, or excessive rainfall events may cause the lift station into the NSDD to be bypassed, creating the potential for migration of contaminated sediment to Bayou Creek. Soil and surface water contaminate concentrations within the watershed of the balance of Outfall 001 do not warrant a removal action. Near-term (i.e., within

two years) remediation of SWMUs within the watershed could disturb and mobilize contaminated surface and shallow subsurface soil and represents the potential for surface water discharge of contamination; therefore, a removal action is proposed for the balance of Outfall 001 (see Section 1.5.1.1).

2.4.2 Outfall 008

The drainage area associated with Outfall 008 is approximately 36.52 ha (90.4 acres). Outfall 008 is a "continuous flow outfall," receiving 850 mgpd of process water. Outfall 004, also a "continuous flow outfall," drains into Outfall 008, contributing an additional 350 mgpd of process water to Outfall 008, for a total process water discharge of 1.2 mgpd. In addition, Outfall 008 receives multiple waste streams from the southwest comer of the PGDP, including miscellaneous wastewaters from buildings such as C-310, C-331, C-400, C-409, C-600 and **C-720.** Soil contaminant concentrations and near-tern remediation proposed for SWMUs within the watershed both are factors contributing to the proposal for a removal action at Outfall 008 (see Section 1.5.1.2).

2.4.3 Outfall 010

The drainage area associated with Outfall 010 is approximately 8.78 ha (22 acres). Under normal operation, all process water ("once-through" cooling waters, steam condensate, and miscellaneous wastewaters from the C-331 Cascade Building) is pumped from Outfall 010 to the C-617 treatment lagoon. Following treatment, all process water from C-617 (0.60 mgpd including process water from Outfall 002, 011, and 012 in addition to that from Outfall 010) is returned to Outfall 010 and discharged into Little Bayou Creek. During periods of mechanical failure, maintenance activities, or excessive rainfall events, the lift station that diverts **flow** to the C-617 treatment lagoon may be bypassed, creating the potential for migration of contaminated sediment to Bayou Creek. Soil and surface water contaminant concentrations within the watershed of Outfall 010 do not warrant a removal action. However, near-term (i.e., within two years) remediation of SWMUs within the watershed could disturb and mobilize contaminated surface and shallow subsurface soil and represents the potential for surface water discharge of contamination; therefore, a removal action is proposed for Outfall 010 (see Section 1.5.1.3).

2.4.4 Outfall 011

The drainage area associated with Outfall 011 is approximately 12.5 ha (31 acres). Under normal operations, all process water and surface water runoff in Outfall 011 is pumped via Lift Station 011 to the C-617 Treatment Lagoon and then directed to Outfall 010 for discharge to Little Bayou Creek. Occasionally (e.g., when Outfall 010 is undergoing maintenance) effluent from the treatment lagoon is piped back to Outfall 011, downstream of the lift station, and from there flows into Little Bayou Creek. However, mechanical failure, maintenance activities, or excessive rainfall events may cause the lift station to be bypassed, creating the potential for migration of contaminated sediment to Little Bayou Creek. Soil and surface water contaminant concentrations and near-term remediation proposed for SWMUs within the watershed all are factors contributing to the proposal for a removal action at Outfall 011 (see Section 1.5.1.4).

2.4.5 Outfall 015

Outfall 015 has a drainage area of approximately 19.8 ha (49 acres). Under normal operating conditions, Outfall 015 receives storm water runoff from the west central portion of PGDP. Historically, Outfall 015 also has received untreated process water from several buildings, including C-400 and C-335. While sediment control measures, such as berms, are present in Outfall 015, the potential for bypass and migration of contaminated sediment to Bayou Creek does exist during excessive rainfall events (i.e., rainfall events that overwhelm existing discharge controls). Soil contaminant concentrations and near-

term remediation proposed for SWMUs within the watershed are both factors contributing **to** the proposal for a removal action at Outfall 015 (see Section 1.5.1.5).

Although removal actions are proposed for each of these five outfalls, the potential for contaminant transport varies from one outfall to another depending on the amount of contamination present in the watershed and on the amount of water that typically flows through the ditch. Therefore, the type of removal action that meets the RAOs and that is most cost effective for one outfall may not be the same as that for another outfall. Descriptions of the possible applicable remedial technologies evaluated as part **of** this removal action and a discussion of the screening methods used to propose which technologies should be applied to each outfall is presented in the following sections.

3. REMOVAL ACTION TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES

This chapter identifies the applicable representative technologies and alternatives that will be considered for the removal actions proposed for Outfalls 008, 010, 011, 015, and the balance of Outfall 001 and discusses the screening process utilized to determine which technologies should be considered for application at each outfall. Analyses of the final alternatives considered are presented in Section 4.

3.1 RESPONSE ACTION DEVELOPMENT

Required periodic monitoring indicates that surface water discharge from Outfalls 008, 010, 011, 015, and the balance of Outfall 001 generally are in compliance with KPDES permit limits designated for the operating facilities at PGDP (only 4 NOVs have been issued for these outfalls during the past 10 years). However, the parameters monitored under these permits do not address all CERCLA COPCs that may be present within the outfall watersheds. The potential for surface water discharge of these CERCLA COPCs in the form of dissolved phase contamination or contaminated sediments that exceed human health **risk** levels of 1×10^{-4} for a child recreator and ecological risk levels of an HI of three could exist at these five outfalls if specific situations were to occur. These situations include the following:

- excessive rainfall events (i.e., rainfall events that overwhelm existing features designed to control surface water runoff);
- infrequent off-normal conditions, such as maintenance activities, when existing runoff and sediment control measures are inoperable;
- implementation of remediation activities at upgradient SWMUs within the watershed that could disturb and mobilize contaminated surface and shallow subsurface soil and, therefore, represents the potential for surface water discharge of contaminated sediment; or
- new upgradient contaminant releases with the potential for off-site transportation of contaminated sediment via storm water runoff.

During meetings conducted in 2000 and early 2001, representatives of DOE, EPA, and the Commonwealth of Kentucky (i.e., the **SWSC** PCT) undertook the task to prioritize the assessment needs for each outfall and to identify the likely response activities required to contain/prevent/minimize the potential surface water discharge of contaminated sediment from PGDP should one of the above identified situations arise. In developing these response actions, the SWSC PCT also considered the recommendation of the CAB that the response actions developed should be commensurate with the specific conditions that currently exist or that are likely to exist in the future at each outfall. The identification of likely response actions for each outfall was based on 1) the degree of contamination known to be present within the outfall watershed; **2)** the potential for future activities within each watershed that could result in the potential release of contaminated sediment and; 3) the degree of uncertainty concerning the current or future levels of contamination that may be present within the watershed.

During the assessment process, three response actions were identified that were likely to be used, independently or in concert with one another, within an outfall watershed to control potential discharge of contaminated sediments:

1. Localized Controls
2. Integrated Controls
3. Systems Controls

The results of the assessment process are summarized in Tables 1.7, 1.10, 1.12, 1.15, and 1.18. The three typical response actions identified are described in the following sections.

3.1.1 Localized Controls

Localized Controls are standard construction practices that are implemented on a SWMU-specific basis to control or minimize local sediment transport. Localized controls are instituted anytime the surface soil could be disturbed during remedial or construction activities. These measures are implemented at the margins of construction sites and represent the first line of sediment control within an outfall watershed. Controls may include placement of straw and seeding of grass over bare spots to inhibit erosion, staking hay bales within ditches and along swales to slow run off, and the installation of silt fences around disturbed areas. Double lines of silt fences can be used if site conditions warrant additional sediment control. The implementation, maintenance, and monitoring of localized controls will be detailed as part of each specific remedial or construction project. Localized Controls are maintained for the duration of a SWMU-specific response action and are monitored as necessary (e.g., visually) to ensure that they are functioning as designed. Localized Controls are a likely response action for all five outfalls that require action.

3.1.2 Integrated Controls

Placement of Integrated Controls within the ditches draining to the outfalls would provide a means to dissipate energy (i.e., reduce flow rate) contained in surface water runoff. Reduction of the flow rate allows suspended solids to drop out of suspension and reduces the amount of sediment remaining in the water (i.e., sediment load), thereby reducing the potential for contaminant migration by surface water transport of sediment. The design of the Integrated Controls and their location in the outfall ditches would allow gravity to influence the suspended particles, resulting in deposition along the stream bottom. The distance between the Integrated Controls and their design would be matched with the expected velocity of water flowing through the ditch and the approximate size of the suspended sediment particulate to achieve maximum effectiveness in reducing sediment loading and potential sediment discharge. For costing purposes in this removal action, rock check dams were selected as the representative Integrated Control; however, during final alternative design, other comparable engineering controls, such channel morphology changes, installation of gabions, or rip-rap may be selected for implementation in addition to, or as a substitute for, rock check dams. Details of the final Integrated Controls design will be documented in the SWSC RAW. Integrated Controls are maintained on a site-wide timeframe [e.g., during the time frame for which remediation is expected at the PGDP (30 years)] and are monitored as necessary (e.g., during storm flow) to ensure that they are functioning as designed. Integrated Controls are a likely response action for all five outfalls that require action.

3.1.3 System Controls

Systems controls are control mechanisms typically installed at the downgradient end of the outfall watershed. System controls are typically implemented on a site-wide timeframe and are monitored to ensure that they are functioning as designed. Sedimentation basins are one example of a common System Control measure that is frequently used in the control of sediment discharge. The basins are designed to

be quiescent basins that would allow suspended solids in the water to settle by gravity at a constant settling velocity. Factors and conditions impacting the effectiveness of basins include the size and specific gravity of particles, the depth and shape of the basin, the flow patterns and currents, and temperature of the water. The storm water is retained for a minimum specified time to allow the particles to settle.

Multiple design options and variations are available for sedimentation basins. For example, discharge either can be continuous, with horizontal flow velocities low enough for particles to settle before reaching the outlet, or the outlet can be closed to completely retain the storm water flow from a specific storm event, with release at a later time. Outlet structures can be fixed, with a perforated riser pipe to drain the basin slowly, or floating outlet structures can be used. Although the features specified in the design may vary, basins can be an effective and relatively low-cost means of reducing suspended solids in water. Operating costs are low.

The evaluation of any proposed sedimentation basins would address the design criteria of a 10-year, 24-hour storm event to the extent practicable. Such an event would result in a 12.7-cm (5-inch) rain during the course of 24 hours. A design to handle this level of storm would exceed those requirements set forth in EPA guidance (EPA 1992) and would provide protection of surface waters, within acceptable risk levels, from potential contaminated sediment migration. However, the SWSC PCT also agreed that credit could be taken for using other sedimentation control measures (i.e., Integrated Controls) in addition to the System Controls, thereby allowing the associated basin to be smaller in size while still meeting the 10-year, 24-hour design criteria for the outfall. The design criteria of the sedimentation basins would provide for a 30-year life expectancy, and the basin would be maintained for the duration of remediation at PGDP (i.e., 30 years). In addition, the design of any proposed sedimentation basin would be compatible with the monitoring of, and the treatment of (if necessary), dissolved phase contamination and contaminated sediment discharged via storm water runoff.

Excavation of a new outfall ditch to route and manage storm water runoff is another System Control that was evaluated to be a viable technology for implementation at PGDP. New outfall ditches would bypass areas of existing contamination and reduce the potential for transport of contaminated sediment. The new drainage ditches would start from manholes and include sections of open channel ditch and sections constructed of 60-inch pipe. The open channel ditch sections would be constructed with riprap for stabilization. Excavation of the new outfall ditches would be implemented in uncontaminated areas; therefore, all soil excavated during the construction of these new outfall ditches would be expected to be "clean" and could be stockpiled and stabilized, pending reuse as backfill on DOE property. In addition, new KPDES outfall stations would be constructed at the end of the new outfall ditches. The remediation of any abandoned sections of outfalls resulting from the implementation of this System Control, would be addressed under a separate SWOU remedial action. System Controls were determined to be a likely response action at Outfalls 008 and 011.

3.1.4 Review of Process Water Contribution to Outfall Discharge

As recommended by the CAB, separation of process water from storm water was another response action that was evaluated for sediment control at Outfalls 008 and 011. This possible response action was considered because process water (i.e., the water used during normal plant operations at PGDP) generally is sediment free, and separation of the process water from the storm water runoff would reduce the overall volume of water to be managed to control sediment runoff and achieve project RAOs.

Process water that flows through Outfall *008* is derived from an area that includes the north half of C-310, the northwest corner cells of C-331, C-400, C-409, C-600, and C-720. Approximately 1 mgpd is generated from these facilities and discharged to the plant storm water system which, in turn, discharges to the Outfall 008 drainage system. This flow ultimately is discharged to Bayou Creek.

Process water that drains through Outfall 011 is derived from an area including **C-3**15, the southwest comer of cells at C-331, and the north half of cells at C-333. Typically process water that is discharged into the internal ditches of Outfall 011 is diverted to the C-617 Treatment Facility and, following treatment, is discharged to Little Bayou Creek via Outfall 010. Process water is discharged to Little Bayou Creek directly through Outfall 011 only during excessive rainfall events (i.e., storm events that overwhelm the existing control features) or during off-normal conditions such as maintenance.

The SWSC PCT suggested that separation of process water would be possible if it could be rerouted prior to being commingled with storm water runoff. The SWSC PCT indicated that a study of current plant systems might be appropriate to determine if separation of the two water sources was feasible.

A preliminary review of the PGDP process water flow system corroborated the fact that the original design and construction of PGDP called for process water and storm water to be combined in a single storm sewer system for discharge into the surrounding creeks. This system has been utilized since plant operations began in 1952. Since 1993, monitoring and handling of all process water at the plant has been the responsibility of USEC.

This preliminary evaluation also indicated that, although the volume of process water flowing through Outfalls 008 and 011 appears to be large, the actual percentage of process water that flows through these outfalls is small (approximately 10%) when compared to the volume of storm water runoff generated during a major storm event (e.g., 1 mgpd of process water at Outfall 008 vs. 9.5 mgpd of storm water runoff from a 5-year, 24-hour event; 10.4 mgpd of storm water runoff from a 10-year, 24-hour event; and 12.6 mgpd of storm water runoff from a 25-year, 24-hour event).

Additionally, based on process knowledge and engineering judgment, technical discussions of possible implementation scenarios for the separation of process water from storm water identified several potential problems that suggest that the separation may not be a practical activity. **A** list of potential problems identified is listed below.

- Process water is an integral part of daily plant operations, and the construction activities required to reroute flow could seriously disrupt critical plant operations.

- The construction of a new underground flow system for process water would require extensive trenching activities. Given the age of the plant and the lack of accurate blueprints for locations of all underground utilities, such extensive subsurface excavation would pose numerous health and safety concerns.

- Because separation of process water and storm water would require a major modification of facility operation at PGDP, a Nuclear Criticality Safety Evaluation would be required to determine if alteration of a 50-year old process would change the Nuclear Safety operating boundaries for the plant.

The cost for an engineering evaluation of the plant process water/storm water system was estimated at approximately $100,000. The estimated time required for performance of this evaluation was three months.

Given the potential negative impacts to the plant worker health and safety, the critical importance of the water systems for the continuous, safe operation of PGDP, the total volume of sediment-laden water to be managed, and the anticipated costs associated with separation of process water/storm water flows, it was determined that separation of process water from storm water was not a beneficial course of action for the control of contaminated sediment runoff at Outfalls 008 and 011; therefore, the separation of process water from storm water was not considered further in the development of this EE/CA.

3.2 ALTERNATIVES TO BE EVALUATED

The following proposed alternatives consist of technologies representative of one or more of the identified response actions and are evaluated in Section 4 of this EE/CA for possible implementation as part of this Site-Wide Sediment Controls Removal Action:

- **Alternative 1 –** No Sediment Control Measures (All Outfalls);
- **Alternative 2 –** Localized Controls and Integrated Controls (Outfalls 010, 015, and the balance of Outfall 001);
- **Alternative 3 –** Localized Controls, Integrated Controls, and System Controls (New Outfall Ditch) (Outfalls 008 and 011); and
- **Alternative 4 –** Localized Controls, Integrated Controls, and System Controls (New Outfall Ditch and Sediment Control Basin) (Outfalls 008 and 011).

Details of the comparison and evaluation process used to select the best alternative from the proposed alternatives are presented in Section 4. For the purposes of this evaluation, specific technologies representative of the response actions proposed have been selected for comparison and costing purposes. Final technical design of the proposed alternative would be addressed in the SWSC RAWP and would be refined according to site-specific requirements to provide optimal performance. The final design of the proposed removal action would be required to meet all project RAOs and would be consistent with the technical approach contained in this EE/CA and the requirements of the Action Memorandum that will be issued following public comment on this EE/CA.

3.3 MONITORING OF ALTERNATIVES

This EE/CA evaluates measures to contain/prevent/minimize the potential surface water discharge of contaminated sediment from PGDP to mitigate exposure to potential down-stream receptors and proposes periodic monitoring of the implemented sediment control measures to ensure that the chosen alternatives perform as expected. Monitoring of the effectiveness of the design elements is critical to the success of the sediment control project.

While periodic monitoring at PGDP indicates that, overall, the five outfalls generally are in compliance with their KPDES permits, the parameters monitored under these permits do not address all CERCLA COPCs that may be present within the outfall watersheds. Therefore, additional monitoring to address specific CERCLA COPCs in both discharged sediment and surface water would be a part of each alternative proposed by this removal action.

A detailed monitoring plan specifying sample location, sampling frequency, and parameters to be monitored will be included in the SWSC RAWP. If monitoring results indicate that treatment is required either for dissolved phase contamination or contaminated sediment in the surface water being discharged from Outfalls 008, 010, 011, 015, or the balance of Outfall 001, a separate CERCLA decision process would be initiated to address this treatment.

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4. ANALYSIS OF ALTERNATIVES

To determine their relative performance, the proposed alternatives discussed in Section 3 were evaluated against the three criteria specified by the EPA. Section 4.1 provides a brief description of the evaluation criteria. Analyses of each individual alternative, based on these three criteria, are presented in Section 4.2. Compliance of the alternatives with ARARs is presented in Section **4.3.** A comparison of the alternatives is included in Section 4.4.

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.

4.1.1 Effectiveness

Effectiveness evaluates the capability of a removal action to meet the goals and scope of the action. Each alternative is evaluated against two broad rules: (a) protectiveness and (b) achievement of removal objectives. The successful alternative must be favorably evaluated for the following criteria.

- **RAOs** – Assess each alternative's ability to meet the RAOs established in Section 2.

- **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 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 from Outfalls 008, 010,011,015, and the balance of Outfall 001. 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.

- **Reduction of Toxicity, Mobility, or Volume through Treatment** – Assess the extent to which the toxicity, mobility, or volume of the contaminants is reduced. There is a statutory preference under CERCLA for removal actions that use treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of hazardous and radioactive substances.

- **Short-Term Effectiveness** – Assess any threats to site workers and the effectiveness and reliability of protective measures that would be taken during the removal action.

4.1.2 Implementability

For implementability, the following three factors were used to assess how realistic a removal alternative is in practice: (a) technical feasibility, (b) administrative feasibility, and (c) resource availability. For a successful implementation of an alternative, the following items must be favorable.

- **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.

4.1.3 Costs

Finally, the alternative is evaluated to determine capital costs.

- **Capital costs –** These are comprised of the expenditures associated with construction, equipment and materials, operation and maintenance (O&M), land and building, relocation and transportation, analytical and treatment services, disposal services, engineering and design, legal fees, mobilization and demobilization, and contingencies.

The following NEPA values, not normally addressed by CERCLA documentation, also are incorporated into 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;
- cultural resources; and
- socioeconomics, including environmental justice and transportation.

The removal action alternatives analyzed in this EE/CA would have no short-term or long-term impacts on land use, T&E species, cultural resources, or socioeconomics. The five remaining NEPA values could sustain some minor short-term impacts due to the implementation of the proposed alternatives. These potential impacts are further analyzed in Section 4.2 during the discussion of the effectiveness evaluation of each alternative. Many of the NEPA values also are addressed in the CERCLA process by compliance with ARARs (e.g., T&E species, wetlands, and cultural resources).

4.2 ANALYSIS OF INDIVIDUAL ALTERNATIVES

4.2.1 Alternative 1 – No Sediment Control Measures (No Action)

The No Sediment Control Measure alternative is a no action alternative. No actions would be required and the current sediment controls would remain in place. This alternative was evaluated for implementation at each of the five outfalls addressed by this removal action.

4.2.1.1 Effectiveness

Alternative lwould not be effective in meeting any of the RAOs stated in Section **2.** The potential for contaminated sediment transport to Bayou Creek and Little Bayou Creek still would exist under certain situations. These situations include excessive rainfall events (i.e., rainfall events that overwhelm existing features designed to control surface water runoff); infiequent off-normal conditions, such as maintenance activities, when existing runoff and sediment control measures are inoperable; the remediation of up-gradient contaminated SWMUs with disturbance of contaminated surface soil could create the potential for contaminated sediment discharge via storm runoff; or the occurrence of new upgradient contamination with the potential for off-site transportation via storm runoff.

No long-term or short-term impacts on land use, air quality and noise, geology and soils, wetlands and floodplains, cultural resources, socioeconomics, and transportation would be expected under this alternative. However, during off-normal conditions, contaminated sediment transport to Little Bayou Creek through Outfalls 010 and 011 and Bayou Creek through Outfalls 001, 008, and 015 could potentially have an adverse impact on the water quality, habitat, and biota of these creeks should such sediment migration occur. Sediment transport offsite could occur as a result of performing future remedial activities. In addition, terrestrial biota could be adversely impacted from direct exposure to contaminated sediment or fiom indirect exposure through the ingestion of aquatic biota that have accumulated contaminants due to exposure.

4.2.1.2 Implementability

No actions are required; therefore, implementability is not a consideration.

4.2.1.3 Cost

There would be no cost for implementing the No Sediment Control Measures Alternative.

4.2.2 Alternative 2 – Localized Controls and Integrated Controls

Alternative 2 consists of using commonly employed construction techniques for sediment control at all construction or remediation site within the watershed of each outfall. Under this alternative, hay bales would be staked in place within drainage swales and ditches at the work sites to filter sediment from the water that drains off the work site. Emplacement of silt fences around the construction site is another localized control that would be used at all construction or remediation sites. At a minimum, one silt fence would be constructed around the disturbed soil area. Silt fences typically are constructed of porous geotextile fabric that is staked in place and buried to prevent surface water underflow.

Integrated Controls to be costed for this alternative will be rock check dams. These dams would be placed in the plant ditches at selected locations upgradient of the outfall and downgradient of work sites. Rock check dams typically are constructed by placing geotextile fabic between riprap aggregate to form a porous dam to temporarily pond water and cause suspended sediment to settle out. Five rock check dams are costed for each outfall in which the alternative is proposed. Spacing of the dams would be based on engineering judgment. Other Integrated Controls such as altering the morphology of the plant ditches, installing gabions, or building mini-retention basins also may be used in addition to, or as a replacement for, construction of rock check dams if such action is determined advantageous to the control of sediment migration during development of the RAWP. Alternative **2** also would provide for periodic monitoring of water flowing from the associated outfalls to determine if dissolved phase contaminants are being discharged and to evaluate the effectiveness of the sediment control systems.

Alternative 2 was evaluated for implementation at Outfalls 010, 015, and the balance of Outfall 001. This alternative also was evaluated as a component of Alternatives 3 and 4, which are considered for implementation at Outfalls 008 and 011. Alternatives **3** and 4 are described in Sections 4.2.3 and 4.2.4, respectively.

4.2.2.1 Effectiveness

Construction of a combination of Localized Controls and Integrated Controls for Outfalls 001, 010, and 015 would be effective in meeting the RAO to minimize discharge of sediment and prevent the potential discharge of contaminated sediment that could contribute to potentially unacceptable risks to receptors. Therefore, Alternative 2 would be protective of human health and the environment.

Alternative 2 would pose minimal impact in terms of additional risks to the community. Although not expected, if contamination were encountered during construction of either the Localized Controls or Integrated Controls, there might be slight increases in risk exposure to on-site workers; however, these **risks** would be managed through the use of appropriate health and safety requirements and PGDP procedures.

No long-term or short-term impacts to land use would occur under Alternative 2. Most of the Localized Controls and Integrated Controls would be constructed inside the plant security fence. Land surrounding Outfalls 001, 010, and 015 currently is undeveloped and is designated as unsecured industrial within the DOE "buffer zone." Land use of the immediate area surrounding the outfalls currently is governed by institutional controls that restrict access to these areas. It is assumed that these controls would remain in place under Alternative 2; thus, land use would remain unchanged.

No long-term impacts to air quality or noise would result from Alternative 2. Localized Controls would be removed once upgradient construction activities are completed. Maintenance of the Integrated Controls should not result in generation of air pollutants, and noise levels should remain similar to current background levels.

Minor short-term impacts to air quality and noise would result from Alternative **2** 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 earthwork activities would be noticeable onsite and in the immediate vicinity. Dispersion would decrease concentrations **of** potential pollutants in the ambient air, as distance from the construction site increased. The use of control measures (e.g., covers and water, or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary National Ambient Air Quality Standards (NAAQS) are expected. Appropriate air monitoring procedures would be followed during the action.

Increased noise levels from the transport and use of construction equipment in the immediate vicinity of both the Localized Controls and Integrated Controls also would be short-term, sporadic, and localized. Noise levels already are slightly elevated in the vicinity of the outfalls because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near the outfalls; thus, no noise impacts would occur.

Alternative **2** would have no impacts on geology and would have only short-term impacts on soils. Site clearing, excavation, grading, and contouring (if needed) would alter the topography of the area where the Localized Controls or Integrated Controls would be located, but the geologic formations underlying those sites would not be affected. Construction could disturb existing soils and some topsoil might be removed in the process. Soil erosion impacts during construction would be mitigated through the use of

Localized Controls (e.g., covers, silt fences, and straw bales). Because the soils in the vicinity of Outfalls 001, 010, and 015 have been previously disturbed as a result of PGDP construction and maintenance activities, no conversion of prime farmland soils is expected to occur.

Alternative 2 would have an overall positive long-term impact on surface water resources by controlling the potential discharge of contaminated sediment into Little Bayou Creek from Outfall 010 and into Bayou Creek fi-om Outfalls 001 and 015. Potential short-term adverse impacts to surface waters could originate from soil erosion, runoff, and increased sedimentation during construction or from the possible release of fuel from construction equipment. Soil erosion impacts would be mitigated through the use of appropriate Localized Controls (e.g., covers, silt fences, straw bales), and the potential for an accidental spill would be mitigated through adherence to proper safety procedures and spill prevention plans. In the event of a spill from an accident, spill response measures (e.g., booms, berms, sorbents, neutralizers, secondary containment, and mechanical removal equipment) would minimize potential adverse impacts to the receiving surface waters. Groundwater resources are unlikely to be adversely affected by the implementation of Alternative **2.**

Linear wetlands with open water are associated with the riparian zone of the ditches leading to each outfall. In addition, a plain forest-maple wetland area is located just north of the Outfall 015 ditch. Integrated Controls construction could cause temporary adverse impacts such as increased siltation/sedimentation due to uncontrolled soil erosion. To the extent possible, all practical measures (e.g., Localized Controls) would be incorporated to minimize adverse impacts. If adverse impacts could not be minimized, wetland restoration or replacement could be required.

The drainage ditches associated with PGDP have not been studied in detail. However, carrying capacity calculations that have been performed indicate that all the drainage ditches would contain the 100-year and 500-year flood discharges associated with Little Bayou Creek and Bayou Creek (COE 1994b). Construction of Integrated Controls would take place within portions of each of the Outfall 001, 010, and 015 ditches, potentially impacting the associated floodplains. If, during the design phase of the removal action, it is determined that wetlands and/or floodplains would be impacted, compliance with the substantive requirements of DOE's regulations for compliance with floodplain/wetlands environmental review requirements (10 *CFR* 1022) would be required. Any restoration and/or mitigation would have to be negotiated among DOE, the Commonwealth of Kentucky, and the COE.

Long-term adverse impacts to ecological resources due to the implementation of Alternative 2 are unlikely since terrestrial and aquatic habitats associated with the outfall ditches are limited due to the industrialized nature of the surrounding areas. Alternative 2 would have a positive impact on the aquatic habitat and biota associated with Little Bayou Creek and Bayou Creek by controlling potential discharge of contaminated sediment into these creeks.

Short-term negative impacts to ecological resources are likely to occur during construction activities associated with Alternative 2. The existing vegetation that provides habitat and food to plants and animals would be eliminated in the vicinity of the work site during construction. Site preparation activities could cause the direct loss of some less mobile wildlife located at the construction site, while other wildlife could be displaced from the construction areas. Soil and sediment disturbance also could potentially redistribute contaminated soil into uncontaminated areas. The degree of these potential impacts would increase with the surface area disturbed. Overall, potential impacts would be minor because the quality of the habitat for wildlife species, especially rare or sensitive species, is extremely limited due to the isolated and fragmented nature of the existing habitat surrounding the outfalls and the close proximity of the outfalls to the industrialized area of PGDP. Recovery to natural conditions would be limited because the Integrated Controls and their immediate surroundings are likely to be maintained.

No federally or state listed T&E plant or animal species have been identified as occurring within or near the ditches associated with Outfalls 001, 010, and 015. The habitat of the federally endangered Indiana bat ***(Myotis** sodalis*) potentially occurs in the vicinity of Little Bayou Creek and Bayou Creek, but no Indiana bat habitat has been identified in the specific areas surrounding Outfalls 001, 010, or 015.

The COE (1994a) survey of cultural resources near the PGDP did not identify any archaeological or historical resources in the vicinity of Outfalls 001, 010, and 015. If any archaeological or historical artifacts or sites were discovered during construction, work in the area would cease and the Kentucky State Historic Preservation Officer would be contacted. Work in the area would not resume until a determination of the significance of the resource was made or until data recovery was complete.

Alternative 2 would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (e.g., utilities, hospitals, and police and fire protection). The workforce that would be required for construction of the Localized Controls and Integrated Controls would be small and likely would be drawn from the local labor market, resulting in no new influx of workers to the area.

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 Alternative **2.** During construction of the Integrated Controls there would be a slight increase in the volume of truck traffic in the vicinity of the outfalls, but the affected roads are capable of handling the additional truck traffic. Localized Controls would be constructed as part of any remedial action but would require only a slight increase in vehicle traffic to deliver supplies (hay bales, geotextile fabric, etc,) and would be of short duration. No off-site shipments of wastes are associated with this action.

Cumulative impacts are those that may result from the incremental impacts of an action considered additive with the impacts of other past, present, and reasonably foreseeable future actions. No notable cumulative impacts resulting from Alternative 2 have been identified except for the positive long-term impacts that would result from the control of potential contaminated sediment discharge.

4.2.2.2 Implementability

Both Localized Controls and Integrated Controls are common sediment control technologies that are easy to construct and install. Placement of hay bales and silt fences made from porous geotextile fabrics within surface swales and small drainage depression around a construction site are common construction industry practice for management of sediment runoff. Localized controls require no large or complex equipment to install or maintain. Rock check dams require only limited equipment to install and maintain and are constructed of readily available material that is easy to handle.

4.2.2.3 Cost

Costs to implement Alternative 2 at Outfalls 001, 010, and 015 would include capital costs for construction and site restoration of the Integrated Controls, O&M costs, and monitoring costs. Since the

cost for Localized Controls would be minimal and the same for each alternative proposed in this removal action, and because these costs are generally included as part of the cost for a specific construction or remediation project, they are not included in the cost estimate for this alternative. The capital cost for implementation of Alternative **2** at Outfalls 001, 010, and 015 is estimated to be **$69,842** and O&M costs for 30 years are estimated to be $317,836.

4.2.3 Alternative 3 – Localized Controls, Integrated Controls, and System Controls (New Outfall Ditches)

Alternative **3** consists of the use of commonly employed construction techniques for sediment control at any construction or remediation site within the impacted watershed of each outfall. This alternative was evaluated for implementation at Outfalls 008 and **01**1. Under this alternative, hay bales would be staked in place within drainage swales and ditches at the work sites to filter sediment from the water that drains **off** the work site. At a minimum, one silt fence would be constructed around the disturbed soil area. Silt fences typically are constructed of porous geotextile fabric that is staked in place and buried to prevent surface water underflow.

The Integrated Controls to be costed for this alternative are rock check dams that would be placed in the plant ditches at selected locations upgradient of the outfall and downgradient of work sites. Rock check dams typically are constructed by placing geotextile fabric between riprap aggregate to form a porous dam to temporarily pond water and cause suspended sediment to settle out. Five rock check dams are costed for each outfall in which the alternative is proposed. Spacing of the dams would be based on engineering judgment. Other Integrated Controls, such as altering the morphology of the plant ditches, installing gabions, or building mini-retention basins may also be used to in addition to, or as a replacement for, construction of the rock check dams. The Localized and Integrated Controls components evaluated for Alternative 3 are the same as those evaluated as Alternative 2 at Outfalls 010, 015, and the balance of Outfall 001.

As a component of Alternative **3,** a new section of outfall ditch also would be excavated upgradient of the current outfall to channel the drainage into the surrounding creek (Bayou or Little Bayou). The original length of channel bypassed would be abandoned and closed off and Integrated Controls would be installed, as necessary, to ensure that the sediments are not transported through this section of ditch. Alternative 3 would provide for periodic monitoring of water flowing from impacted outfalls to determine if dissolved phase contaminants were being discharged and to evaluate the effectiveness of the sediment control systems.

4.2.3.1 Effectiveness

Emplacement of Localized Controls, Integrated Controls, and the construction of a new outfall ditch at Outfalls 008 and 011 would be effective in meeting the RAO to minimize sediment discharge and prevent the potential discharge of contaminated sediment that can contribute to potentially unacceptable risks to receptors. Both Localized Controls, including emplacement of hay bales and silt fences at any construction areas, and Integrated Control, such as building rock check dams at intervals along plant ditches to retain sediment discharge, would be utilized under Alternative 3. Additionally, a section of the existing outfall ditches at Outfalls 008 and 011 would be abandoned and replaced, thereby removing the possibility of further erosion of contaminated sediment from these existing ditches during storm flow events. Entrapment of contaminated sediment upgradient of the outfalls and the elimination of the potential for remobilization of contaminated sediment within the outfalls would eliminate potential discharge of contaminated sediments to Bayou Creek and Little Bayou Creek from the Outfalls 008 and 011, respectively, except during storm flow events when the Integrated Controls would be overwhelmed. Therefore, Alternative 3 would be only partially protective of human health and the environment.

Alternative 3 would pose minimal impact in terms of additional risks to the community. Although not expected, if contamination were encountered during construction of new outfalls, there might be slight increases in **risk** exposure to on-site workers; however, these risks would be managed through the use of health and safety requirements and PGDP procedures.

No long-term or short-term impacts to land use would occur under Alternative 3. Land surrounding the current locations of outfalls is undeveloped and is designated as unsecured industrial within the DOE "buffer zone." It is assumed that the new outfalls would be located in the immediate vicinity of the existing outfalls where land use is similarly defined. Land use of the immediate area surrounding the existing Outfalls 008 and 011 currently is governed by institutional controls that restrict access to these areas. It is assumed these controls would remain in place not only for the existing locations, but also would be instituted for the newly constructed outfalls; thus, land use would remain unchanged.

No long-term impacts to air quality or noise would result from Alternative 3. Construction of Localized Controls and Integrated Controls and the new outfalls would not result in generation of air pollutants, and noise levels should be similar to current background levels.

Minor short-term impacts to air quality and noise would result 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 earthwork activities would be noticeable onsite and in the immediate vicinity. Dispersion would decrease concentrations of potential pollutants in the ambient air, as distance from the construction site increased. The use of control measures (e.g., covers and water, or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary NAAQS are expected. Appropriate air monitoring procedures would be followed during the action.

Increased noise levels from the transport and use of construction equipment in the immediate vicinity of the new outfalls also would be short-term, sporadic, and localized. Noise levels already are slightly elevated in the vicinity of the outfalls because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near the outfalls; thus, no noise impacts would occur.

Alternative **3** would have no impacts on geology and would have only short-term impacts on soils. Site clearing, excavation, grading, and contouring would alter the topography of the area where the new outfalls would be located, but the geologic formations underlying those sites would not be affected. Construction could 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, silt fences, and straw bales). It is assumed the new outfalls would be constructed in the vicinity of the existing Outfalls 008 and 011. If true, the soils in this area have been previously disturbed as a result of PGDP construction and maintenance activities, and no conversion of prime farmland soils is expected to occur.

Alternative 3 would have an overall positive long-term impact on surface water resources by decreasing the potential discharge of contaminated sediment into Little Bayou Creek from Outfall 011 and into Bayou Creek from Outfall 008. Potential short-term adverse impacts to surface waters could originate from soil erosion, runoff, and increased sedimentation during construction or from the possible release of fuel from construction equipment. Soil erosion impacts would be mitigated through the use of appropriate Localized Controls (e.g., covers, silt fences, straw bales), and the potential for an accidental spill would be mitigated through adherence to proper safety procedures and spill prevention plans. In the event of a spill from an accident, spill response measures (e.g., booms, berms, sorbents, neutralizers, secondary

containment, and mechanical removal equipment) would minimize potential adverse impacts to the receiving surface waters. Groundwater resources are unlikely to be adversely affected by the implementation of Alternative 3.

Linear wetlands with open water are associated with the riparian zone of the ditches leading to each outfall. In addition, a plain forest-maple wetland area is located north of the Outfall 008 ditch. Outfall construction could cause temporary adverse impacts to these resources such as increased siltation/ sedimentation due to uncontrolled soil erosion. To the extent possible, all practical measures (e.g., erosion controls) would be incorporated to minimize adverse impacts. If adverse impacts could not be minimized, wetland restoration or replacement could be required. With the diversion of water from the existing outfalls to newly constructed ones, it is likely that the linear wetlands and open water currently associated with Outfalls 008 and 011 would be depleted. The abandoned outfalls and ditches are not to be filled with soil. This would leave them available for seasonal wetness and consequential habitat development. Over time, additional wet areas and open water would be associated with the newly constructed outfalls.

The drainage ditches associated with PGDP have not been studied in detail. However, carrying capacity calculations that have been performed indicate that all the drainage ditches would contain the 100-year and 500-year flood discharges associated with Little Bayou Creek and Bayou Creek (COE 1994b). Construction of new outfalls would take place within portions of the existing Outfall 008 and 011 ditches, potentially impacting the floodplains. If, during the design phase of the removal action, it is determined that wetlands and/or floodplains would be impacted, compliance with the substantive requirements of DOE's regulations for compliance with floodplain/wetlands environmental review requirements (10 *CFR* 1022) would be required. Any restoration and/or mitigation would have to be negotiated among DOE, the Commonwealth of Kentucky, and the COE.

Long-term adverse impacts to ecological resources would be minor since terrestrial and aquatic habitats associated with the area are limited due to the industrialized nature of the surrounding areas. There would be minor habitat loss in the areas where new outfalls are to be constructed due to excavation and outfall development. Abandoned outfalls and associated ditches would remain available for habitat use, but with a lower water volume than previously present. Alternative 3 would have a positive impact on the aquatic habitat and biota associated with Little Bayou Creek and Bayou Creek by controlling potential discharge of contaminated sediments into these creeks.

Short-term negative impacts to ecological resources are likely to occur during construction activities associated with Alternative 3. The existing vegetation that provides habitat and food to plants and animals would be eliminated in the vicinity of the work site during construction. Site preparation activities could cause the direct loss of some less mobile wildlife located at the construction site, while other wildlife could be displaced from the construction areas. Soil and sediment disturbance also potentially could redistribute contaminated soil into uncontaminated areas. The degree of these potential impacts would increase with the surface area disturbed. Overall, potential impacts should be minor because the quality of the habitat for wildlife species, especially rare or sensitive species, is extremely limited due to the isolated and fragmented nature of the existing habitat surrounding the outfalls and the close proximity of the outfalls to the industrialized area of PGDP. It is assumed that the new outfall locations would be within the same vicinity. Recovery to natural conditions after construction would be limited because the new outfalls and their immediate surroundings are likely to be maintained.

No federally or state listed T&E plant or animal species have been identified as occurring within or near the ditches associated with the outfalls. The habitat of the federally endangered Indiana bat ***(Myotis sodalis***) potentially occurs in the vicinity of Little Bayou Creek and Bayou Creek, but no Indiana bat habitat has been identified in the specific areas surrounding the outfalls.

The COE (1994a) survey of cultural resources near the PGDP did not identify any archaeological or historical resources in the vicinity of the outfalls. If any archaeological or historical artifacts or sites were discovered during construction, work in the area would cease and the Kentucky State Historic Preservation Officer would be contacted. Work in the area would not resume until a determination of the significance of the resource was made or until data recovery was complete.

Alternative **3** would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (e.g., utilities, hospitals, and police and fire protection). The workforce that would be required for construction of Localized and Integrated Controls and the new outfalls would be small and likely would be drawn from the local labor market, resulting in no new influx of workers to the area.

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 Alternative **3.** During construction of the new outfalls there would be a slight increase in the volume of truck traffic in the vicinity of the new outfalls, but the affected roads are capable of handling the additional truck traffic. No off-site shipments of wastes are associated with this action.

Cumulative impacts are those that may result from the incremental impacts of an action considered additive with the impacts of other past, present, and reasonably foreseeable future actions. No notable cumulative impacts resulting from Alternative **3** have been identified except for the positive long-term impacts that would result from the control of the transport of contaminated sediment.

4.2.3.2 Implementability

Both Localized Controls and Integrated Controls are easy to construct and install. Placement of hay bales and silt fences made from porous geotextile fabrics within surface swales and small drainage depressions around a construction site are common construction industry practice for management of sediment runoff. Localized Controls require no large or complex equipment to install or maintain. Rock check dams require only limited equipment to install and maintain and are constructed of readily available materials that is easy to handle.

Implementation of Alternative 3 at Outfalls 008 and 011 also would require excavation of new drainage ditches, installation of piping and manholes, and construction of new KPDES outfall stations. Construction of KPDES outfall stations and of properly sized drainage ditches to allow for the routing and management of storm water are relatively simple engineering tasks that could be accomplished using common industrial methods. Design issues that would have to be considered for the construction of the drainage ditches include:

- topography of the area (gravity flow);
- flow rates to be addressed (piping size and capacity);
- amount of acreage available for construction (excavation);
- necessity of a spoils area for excavated soil (soil management);

- existing utility interference (rerouting, outfall tie-in, etc.); and
- potential excavation of contaminated soil (waste management and disposal).

Operation of the new outfall ditches and stations would require only routine inspection and cleanout as necessary.

4.2.3.3 Cost

Costs to implement Alternative 3 at Outfalls 008 and 011 would include capital and O&M costs for construction of the Integrated Controls (rock check dams) within the plant ditches and for excavation of new outfall ditches Since the cost for Localized Controls would be minimal and the same for each alternative proposed in this removal action, and because these costs are generally included as part of the cost for a specific construction or remediation project, they are not included in the cost estimate for this alternative. The capital cost for implementation of Alternative 3 at Outfall 008 is estimated to be $1,159,657 and O&M costs for **30** years are estimated to be $333,836. The capital cost for implementation of Alternative **3** at Outfall 011 is estimated to $1,288,917; O&M costs for **30** years at Outfall 011 are estimated to be $333,836.

4.2.4 Alternative 4 – Localized Controls, Integrated Controls, and System Controls (New Outfall Ditches and Sedimentation Basin)

Alternative 4 consists of using commonly employed construction techniques for sediment control at any construction or remediation site within the impacted watershed of each outfall and was evaluated for implementation at Outfalls 008 and 011. Under this alternative, hay bales would be staked in place within drainage swales and ditches at the work sites to filter sediment from the water that drains off the work site. At a minimum, one silt fence would be constructed around the disturbed soil area. Silt fences typically are constructed of porous geotextile fabric that is staked in place and buried to prevent surface water underflow.

The Integrated Controls to be costed for this alternative would be rock check dams that would be placed in the plant ditches at selected locations upgradient of the outfall and downgradient of work sites. Rock check dams typically are constructed by placing geotextile fabric between riprap aggregate to form a porous dam to temporarily pond water and cause suspended sediment to settle out. Five rock check dams are costed for each outfall in which the alternative is proposed. Spacing of the dams would be based on engineering judgment. Other Integrated Controls, such as altering the morphology of the plant ditches, installing gabions, or building mini-retention basins also may be used in addition to, or as a replacement for, construction of the rock check dams, if determined to be advantageous to the control of sediment migration during development of the RAWP.

As a component of Alternative 4, a new section of outfall ditch also would be excavated upgradient of the current outfall to channel the drainage into the surrounding creek (Bayou or Little Bayou). The original length of channel would be abandoned and closed off and Integrated Controls would be installed, as necessary, to ensure that the sediments are not transported through this section of ditch. The Localized and Integrated Controls components (Alternative 2) and the new outfall ditch component evaluated **as** Alternative 4 are the same as those evaluated as Alternative 3 at Outfalls 008 and 011.

Additionally, as a part of Alternative 4, a sedimentation basin would be constructed near the existing outfall to retain surface water runoff and allow for suspended sediment to settle out of suspension before the water is released to the creeks (Bayou or Little Bayou). If feasible, the basins would be constructed to meet **a** design criteria of a 10-year, 24-hour storm event. Alternative 4 also would provide for periodic

monitoring of water flowing from Outfalls 008 and 011 to determine if dissolved phase contaminants were being discharged and to evaluate the effectiveness of the sediment control systems.

4.2.4.1 Effectiveness

Construction of sedimentation basins, when combined with excavation of new outfall ditches and placement of Localized Controls and Integrated Controls, would be highly effective in meeting the RAOs at Outfalls 008 and 011 of minimizing sediment discharge and preventing the potential discharge of contaminated sediment that can contribute to potentially unacceptable risks to receptors. The alternative would achieve this by containing sediment carried by surface water flow in Outfall 008 and 011, even during storm events, before it could be discharged to Bayou Creek and Little Bayou Creek, respectively. Alternative 4 would provide for overall protection of human health and the environment.

Alternative 4 would pose minimal impact in terms of additional risks to the community. Although not expected, if soil contamination were encountered during excavation of basins or new outfall ditches, there might be slight increases in risk exposure to on-site workers; however, these risks would be managed through the use of health and safety requirements and PGDP procedures.

No long-term or short-term impacts to land use would occur under Alternative 4. Land surrounding Outfalls 008 and 011 currently is undeveloped and is designated as unsecured industrial within the DOE "buffer zone." Land use of the immediate area surrounding the outfalls currently is governed by 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.

No long-term impacts to air quality or noise would result from Alternative 4. Operation of the sedimentation basins would not result in generation of air pollutants, and noise levels should be similar to current background levels.

Minor short-term impacts to air quality and noise would result 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 onsite and in the immediate vicinity. Dispersion would decrease concentrations of potential pollutants in the ambient air as distance from the construction site increased. The use of control measures (e.g., covers and water, or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary NAAQS are expected. Appropriate air monitoring procedures would be followed during the removal action.

Increased noise levels from the transport and use of equipment in the immediate vicinity of the sedimentation basins and new outfall ditches also would be short-term and sporadic during construction. Noise levels already are slightly elevated in the vicinity of the outfalls because of their close proximity to the industrialized portion of PGDP. No sensitive noise receptors (e.g., residences) are located near the outfalls; thus, no noise impacts would occur.

Alternative 4 would have minimal impacts on geology and would have only short-term impacts on soils. Site clearing, excavation, grading, and contouring would alter the topography of the area where the sedimentation basins and new outfall ditches would be located, but the geologic formations underlying those sites would not be affected. Construction would disturb existing soils, and some topsoil would be removed in the process. Soil erosion impacts during construction would be mitigated through the use of Localized Controls (e.g., covers, silt fences, and straw bales). Because the soils in the vicinity of the

Outfalls 008 and 011 have been previously disturbed as a result of PGDP construction and maintenance activities, no conversion of prime farmland soils is expected to occur.

Alternative 4 would have an overall positive long-term impact on surface water resources by controlling the potential discharge of contaminated sediment into Little Bayou Creek from Outfall 011 and into Bayou Creek from Outfall 008. Potential short-term adverse impacts to surface waters could originate from soil erosion, runoff, and increased sedimentation during construction or from the possible release of fuel from construction equipment. Soil erosion impacts would be mitigated through the use of appropriate control measures (e.g., covers, silt fences, straw bales), and the potential for an accidental spill would be mitigated through adherence to proper safety procedures and spill prevention plans. In the event of a spill from an accident, spill response measures (e.g., booms, berms, sorbents, neutralizers, secondary containment, and mechanical removal equipment) would minimize potential adverse impacts to the receiving surface waters. Groundwater resources are unlikely to be adversely affected by the implementation of Alternative 4. However, changes in surface topography during construction could lead to minor alterations of the local hydrology.

Linear wetlands with open water are associated with the riparian zone of the ditches leading to Outfalls 008 and 011. In addition, a plain forest-maple wetland area is located north of the Outfall 008 ditch. Construction of new outfalls could cause temporary adverse impacts to these resources such as increased siltation/sedimentation due to uncontrolled soil erosion. To the extent possible, all practical measures (e.g., erosion controls) would be incorporated to minimize adverse impacts. If adverse impacts could not be minimized, wetland restoration or replacement could be required. With the diversion of water from the existing Outfall 008 to a newly constructed one, it is likely that the linear wetlands and open water currently associated with the Outfall 008 would be depleted. The abandoned outfall and ditch are not to be filled with soil. This would leave them available for seasonal wetness and consequential habitat development. Over time, additional wet areas and open water would be associated with the newly constructed outfall.

The drainage ditches associated with PGDP have not been studied in detail. However, carrying capacity calculations that have been performed indicate that all the drainage ditches would contain the 100-year and 500-year flood discharges associated with Little Bayou Creek and Bayou Creek (COE 1994b). Construction of the sedimentation basins and new outfall ditches would take place within a portion of the Outfalls **008** and 011 ditches. Construction potentially could impact the associated floodplains. If during the design phase of the removal action it is determined that wetlands and/or floodplains would be impacted, compliance with the substantive requirements of DOE's regulations for compliance with floodplain/wetlands environmental review requirements (10 *CFR* 1022) would be required. **Any** restoration and/or mitigation would have to be negotiated among DOE, the Commonwealth of Kentucky, and the COE.

Long-term adverse impacts to ecological resources are unlikely since terrestrial and aquatic habitat associated with the outfall ditches is limited due to the industrialized nature of the surrounding areas. Alternative 4 would have a positive impact on the aquatic habitat and biota associated with Little Bayou Creek and Bayou Creek by controlling potential discharge of contaminants into these creeks.

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 during construction of the sedimentation basins and in the vicinity of the area chosen for placement of clean soil excavated during basin construction. Site preparation activities and excavation also could cause the direct loss of some less mobile wildlife located at the construction site or at the placement site for clean, excavated soil, while other wildlife could be displaced from the cleared areas. Excavation also potentially could redistribute contaminated soil into uncontaminated areas. The degree of these potential impacts would increase with the surface area removed and the amount of clean soil excavated. Overall, potential impacts should be minor because the quality of the habitat for wildlife species, especially rare or sensitive species, is extremely limited due to

the isolated and fragmented nature of the existing habitat surrounding the outfalls and the close proximity of the outfalls to the industrialized area of PGDP. Recovery to natural conditions at the construction site would be limited because the sedimentation basins and their immediate sun-oundings are likely to be maintained. However, clean soils that were relocated following excavation would be graded and revegetated with native trees and grasses to facilitate recovery to natural conditions.

No federally or state listed T&E plant or animal species have been identified as occumng within or near the ditches associated with Outfalls 008 and 011. The habitat of the federally endangered Indiana bat (*Myotis sodalis*) potentially occurs in the vicinity of Little Bayou Creek and Bayou Creek, but no Indiana bat habitat has been identified in the areas surrounding the outfalls.

The COE (1994a) survey of cultural resources near the PGDP did not identify any archaeological or historical resources in the vicinity of Outfalls 008 and 011. If any archaeological or historical artifacts or sites were discovered during construction, work in the area would cease and the Kentucky State Historic Preservation Officer would be contacted. Work in the area would not resume until a determination of the significance of the resource was made or until data recovery was complete.

Alternative 4 would not have any direct or indirect adverse impacts on local socioeconomic resources such as population, employment, housing, schools, public services, and local government expenditures (e.g., utilities, hospitals, and police and fire protection). The workforce that would be required for construction of the sedimentation basins would be small and likely would be drawn from the local labor market, resulting in no new influx of workers to the area.

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 Alternative 4. During construction of the sedimentation basins and new outfall ditches, there would be a slight increase in the volume of truck traffic in the vicinity of the outfalls, but the affected roads are capable of handling the additional truck traffic. No off-site shipments of wastes are associated with this action.

Cumulative impacts are those that may result from the incremental impacts of an action considered additive with the impacts of other past, present, and reasonably foreseeable future actions. No notable cumulative impacts resulting from Alternative 4 have been identified except for the positive long-term impacts that would result from the control of storm water runoff and sediment.

4.2.4.2 Implementability

Localized and integrated controls such as inplacement of hay bales and rock check dams are common industry practices and would be easily implemented. For costing purposes in this document, rock check dams were chosen as the technology representative of Integrated Controls. Construction and operation of a sedimentation basin is not complex, and the technology, a proven and commonly employed method for sediment control, is readily available. Construction of the sedimentation basins, excavation of new outfall ditches, and construction of new KPDES outfall stations for both Outfalls 008 and 011 could be accomplished using common industrial practices.

Several major design issues would have to be considered for the sedimentation basin alternative. These issues would include:

- topography of the area (gravity flow);
- flow rates to be addressed (basin and culvert size and capacity);
- size of area available for construction;
- necessity of a spoils area for excavated soil (soil management);
- existing utility interference (rerouting, outfall tie-in, etc.); and
- excavation of contaminated soil (waste management and disposal).

In addition, multiple pieces of large earth-moving equipment would be required to complete construction in a timely manner.

A primary consideration in the evaluation of Alternative 4 for implementation at Outfalls 008 and 011 was the areas available to locate the sedimentation basins. Paducah is a fully developed industrial complex and potential locations for sedimentation basins that meet the design criteria of a 10-year, 24-hour storm event (i.e., 5 inches of rain in 24 hours) are limited. At Outfall 008, particularly, topography, existing utilities, and plant structures place severe constraints on the placement and size of the basin.

Two areas in the vicinity of Outfall 008 were initially considered as potential sites for a sedimentation basin. The first of these is a tract of approximately 6.5 acres located outside of the PGDP security fence to the north of Outfall 008 and to the south of Outfall 015 (see Figure 4.1). Factors considered during the evaluation of this area as the possible site for construction of a sedimentation basin are listed below.

- Implementation of Alternative 4 at this location would achieve the project RAOs.

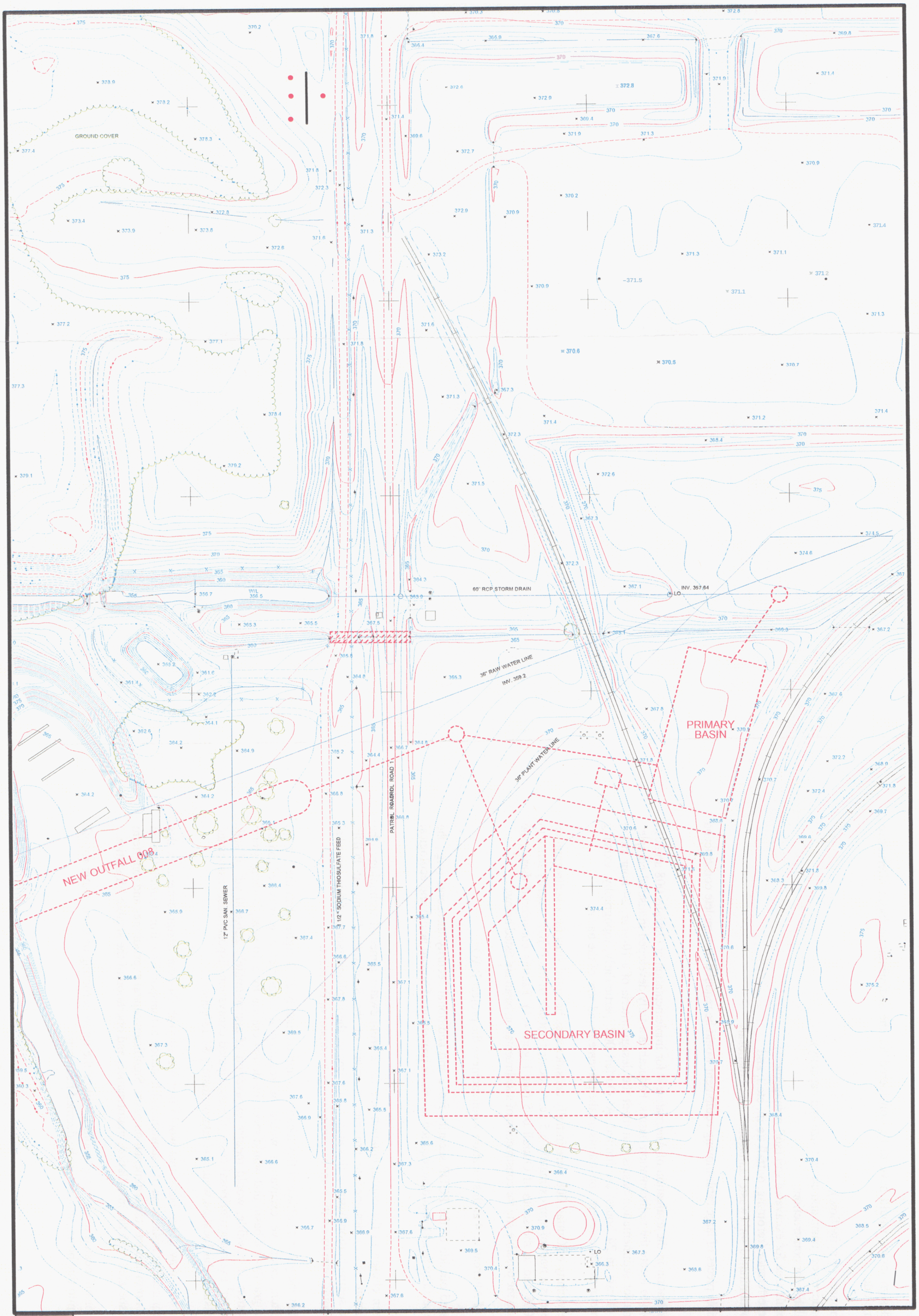
- This area is located outside of the PGDP security fence and additional security measures (e.g., the construction of a security fence) would be required to ensure protection of human health and ecological receptors.

- This area has been chosen as the implementation site for a groundwater remedial technology (the Permeable Treatment Zone) designed to provide treatment of the Southwest Plume at PGDP. Construction of a sedimentation basin in this area would impact the implementation of this remedial technology and would interfere with planned groundwater treatment at the plant.

- Due to the fact that the ground surface at this location is approximately 25 ft higher than the bottom of the outfall ditch, extensive excavation would be required to construct a gravity-fed basin. Construction of a gravity-fed basin that would meet the design criteria for a 10-year, 24-hour storm event at this location, if possible, would require excavation of approximately 226,000 yd^3 of soil. Assuming $5 per yd^3 excavatioddisposal costs, the anticipated excavation/disposal costs associated with building a basin at this location would be approximately $1,130,000.

- Construction of a non-gravity fed basin that would met the 10 year, 24-hour design criteria in this location would required the installation of a substantial lift station to transport flow from Outfall 008 up the 25 ft hill to the north and into the sedimentation basin. Significant capital expenditures and long-term costs would be associated with the installation, maintenance, and operation of the sizable lift station.

- A sedimentation basin located in this area would facilitate the future rerouting of storm water runoff from Outfall 015 into this basin, should that be deemed necessary.



U.S. DEPARTMENT OF ENERGY
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Fig. 4.1. Outfall 008 sediment basin.

FIGURE No. c5ac90000sk140.apr
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The second location reviewed as a possible site for a sedimentation basin at Outfall 008 is a 4.25 acre, triangular-shaped tract located inside the security fence to the south of Outfall 008 (see Figure 4.1). This area is bounded on the east by a railroad track, on the west by the security fence, and to the south by the sewer treatment plant. Features of this area and their probable impact on basin construction are described below.

- Implementation of Alternative 4 at this location would achieve the project RAOs.

- The area south of Outfall 008 is located within the PGDP security fence, and no additional security measures (or costs) would be required to ensure protection of human health or ecological receptors.

- The area south of Outfall 008 is relatively flat and less excavation would be required to construct a sedimentation basin. Less excavation would result in lower initial excavation/disposal costs. The area is approximately the same topographic height as Outfall 008; therefore, only a small lift station would be required to move outfall flow within the sedimentation basin system. This would mean lower upfront capital cost and lower long-term operating costs.

- A sedimentation basin located in this area would facilitate the future rerouting of storm water runoff from Outfall 015 into this basin, should that be deemed necessary. Capacity of the sedimentation basin proposed for the current removal action will be sufficient to contain storm water runoff from both outfalls without significant modifications when additional sediment control measures (i.e., Integrated Controls) are installed within the watershed of Outfall 015.

- The area is not large enough to accommodate a basin that would meet a design criteria of a 10-year, 24-hour storm event.

Alternative 4 could be implemented at either location and still achieve the project RAOs and, therefore, either location could be proposed as the construction site for a sedimentation basin. After evaluating the pros and cons of constructing a basin at each location, the smaller location south of Outfall 008 (within the security fence), as discussed in the following paragraphs, is deemed to be the better choice for implementation of Alternative 4.

Although a larger sedimentation basin probably could be constructed at the site outside the security fence, several factors detract from the proposal of that location. These factors include security concerns and the higher initial construction costs and higher long-term operating costs required by a higher topographical location.

A summary of the major differences in estimated construction costs is provided in Table 4.1. Additionally, the area outside of the security fence north of Outfall 008 is the area that has been proposed for the installation of a groundwater remediation system to address the Southwest Plume at PGDP. Due to this potential conflict with other planned remedial work at PGDP, the proposal of this site for the construction of a sedimentation basin is less desirable.

Table 4.1. Comparison of major differences in estimated construction cost differences for the two possible Outfall 008 basin locations

Cost Item	Location outside of fence, north of Outfall 008	Location inside of fence, south of Outfall 008 (proposed location)
Basin Excavation	$1,130,000	$101,000
Lift Stations	$140,000	*$60,000*
Utilities (Electric consumption)	$9,600 per year	$1,200 per year

Although the size of the area inside the fence south of Outfall 008 does not allow for the construction of a sedimentation basin that would fully accommodate a design criteria of a 10-year, 24-hour storm event (5 inches of rain in 24 hours), a basin could be constructed in this area that would accommodate at least a 2-year, 24-hour storm event (i.e., 3.5 inches of rain in 24 hours) and possibly up to a 5-year, 24-hour storm event (i.e., 4.7 inches of rain in 24 hours). However, as discussed below, it would be possible to utilize additional sediment control measures within the watershed of Outfall 008 to augment the protection provided by the smaller basin and achieve the same overall protection as afforded by the 10-year, 24-hr design criteria.

In addition to the control of sediment mobilization in the upper portions of the Outfall 008 watershed, one of the primary objectives of this removal action was to eliminate the possibility of mobilization of contaminated sediments within the Outfall 008 drainage ditch downstream of the security fence. During initial remedial alternative evaluations, it was assumed that a sedimentation basin built to the design criteria of a 10-year, 24-hour storm event would be needed to ensure that the contaminated sediment was not remobilized. When evaluating the area south of Outfall 008 as a potential basin location, it was determined that, given the reduced basin size that could be accommodated in that area, additional sediment control measures would be required to meet this performance objective.

The Outfall 008 watershed is approximately **90** acres in size. Of this, approximately 78% (70 acres) is primarily urban (i.e., the watershed drains from roofs, streets, and parking lots into a subsurface drain system) and contributes very little sediment to the outfall. The remaining **22%** (20 acres) receives surface water drainage primarily from vegetated land surfaces within PGDP. The installation of additional sediment control features such as Integrated Controls (e.g. rock check dams) in the ditches that drain surface water flow from these areas into Outfall 008 would augment the control provided by the sedimentation basin. Additionally during implementation of Alternative 4, the old contaminated segment of Outfall **8** would be by-passed (thereby eliminating the possibility for remobilization of contaminated sediment), and a new drainage ditch would be constructed to receive the flow from Outfall 008. This use of a combination of Integrated Controls, ditch excavation, and sedimentation basin technology would fully achieve the project RAOs of preventing/minimizing contaminated sediment transport, even though a basin smaller than a 10-year, 24-hour design is proposed. A generalized design of the sedimentation basin proposed for Outfall 008 is shown on Figure B-1 in Appendix B. To maximize containment potential while minimizing space requirements available at Outfall 008, the design calls for the construction of inline primary and secondary basins to control excavation/waste disposal costs. Soils excavated during construction of the primary basin would be used to construct an aboveground berm in which the secondary basin would be located. This would reduce the amount of soil to be excavated and disposed, thereby reducing costs. The base of the secondary basin would be excavated slightly below grade to maximize containment potential.

At Outfall 011, ample space is available for construction of a basin that would achieve the 10-year, 24-hour design criteria. The topography is low and flat and the location would not present a problem for the installation of a sedimentation basin. One determining factor at Outfall 011 was to propose a basin location that could be integrated into future site wide sedimentation projects, should the need arise. The proposal to place the Outfall 011 basin to the north of the Outfall 011 ditch considers the proximity of this location to Outfall 010. While the preliminary screening of Outfall 010 conducted by the SWSC PCT indicated that the installation of a sedimentation basin at Outfall 010 currently is not required, placement of the Outfall 011 basin was proposed so that it would be possible to utilize it for Outfall 010 runoff should it become necessary in the future.

A generalized design of the Sedimentation basin proposed for Outfall 011 is shown on Figure B-2 in Appendix **B.** This design calls for the construction of a primary and a secondary basin that will function as a gravity system. The primary basin will provide oil control, stormwater stilling, and will temporarily detain stormwater. The secondary basin will consist of an entrance structure, settling zone, and discharge

structure. Soils excavated during construction of the basins would be placed in an appropriate area and would be graded and revegetated with native grasses and trees to facilitate recovery to natural conditions.

In addition to the construction of sedimentation basins with gravity settling, Alternative 4 also would provide for periodic monitoring of water flowing from Outfalls 008 and 011 to determine if dissolved phase contaminants were being discharged.

4.2.4.3 Cost

Costs to implement Alternative 4 at Outfalls 008 and 011 would include capital and O&M costs for construction of the Integrated Controls (rock check dams) within the plant ditches and for excavation of new outfall ditches and construction of sedimentation basins. Since the cost for Localized Controls would be minimal and the same for each alternative proposed in this removal action, and because these costs are generally included as part of the cost for a specific construction or remediation project, they are not included in the cost estimate for this alternative. Capital costs for implementation of this alternative at Outfall 008 are estimate to be $2,950,935; O&M costs for 30 years are estimated to be $1,970,302. Capital costs for implementation of this alternative at Outfall 011 are estimated to be $2,172,159; O&M costs for 30 years at Outfall 011 are estimated to be $1,811,302.

4.3 COMPLIANCE WITH ARARS

In accordance with Section 300.415(j) of 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* 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 would 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 (e.g., surface water, groundwater, soil, or air) for specific hazardous substances, pollutants, or contaminants. Action-specific *ARARs* include operation, performance, and design requirements or limitations based on waste types, media, and removal/remedial activities.

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 in the absence of *ARARs*. A list of potential ARARs and TBCs has been identified to address the alternatives proposed in this EE/CA and is included as Appendix C.

The removal action alternatives proposed in this document would comply with the appropriate, identified *ARARs* and TBCs, to the extent practicable.

Implementation of Alternatives 2, 3, and 4 would comply with the *ARARs* specified in Appendix C. Required measures would be incorporated into the design phase and implemented during the construction and operation phases of the Removal Action. 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. Soil and other waste materials generated as a result of this removal action would be properly characterized and disposed of in accordance with the ARARs found in Appendix C. All on-site management of such materials would be conducted as specified within the applicable regulatory requirements as determined appropriate after characterization. It is not anticipated that endangered or protected species (including migratory birds), or their habitats, would be impacted by this action. However, as the action would result in changes to the ditches that currently discharge to local creeks, impacts could occur due to flow rate changes during the implementation phase. Any impact to the local habitat, including wetlands, would be mitigated to the extent practicable.

4.4 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 4.2.

4.4.1 Effectiveness

Alternative 1, No Sediment Control Measures (No Action) was considered for each of the five outfalls (Outfalls 001,008,010, 011, and 015) included in this removal action. This alternative would not minimize sediment discharge at these five outfalls or prevent the potential for current discharge of contaminated sediment from Outfalls **008** and 011, nor the potential future discharge of contaminated sediment associated with planned remedial activities at Outfalls 001, 010, and 015. Therefore, Alternative 1 would not be effective in controlling sediment transport and would not satisfy the RAOs.

Alternative **2,** which would include a combination of Localized and Integrated Controls at Outfalls 001, 010, and 015, would minimize sediment transport and prevent the potential discharge of contaminated sediments from these outfalls during performance of future remedial activities. Therefore, Alternative 2 would be effective in controlling sediment transport and would satisfy the RAOs.

Alternative **3,** which would include a combination of Localized Controls, Integrated Controls, abandonment of contaminated outfall ditches, and excavation of new outfall ditches at Outfalls 008 and 011, would minimize sediment transport and prevent contaminated sediment migration offsite during periods of normal operation through the bypass of areas of known contamination. However, the potential for off-site migration of contaminated sediment from upgradient locations within the watershed still would exist during storm events. Therefore, Alternative 3 would be partially effective in controlling sediment transport and would not fully satisfy the RAOs.

Alternative 4, which would include a combination of Localized Controls, Integrated Controls, abandonment of contaminated outfall ditches, excavation of new outfall ditches, and construction of sedimentation basins at Outfalls 008 and 011, would minimize sediment transport and prevent contaminated sediment migration offsite during periods of normal operation through the bypass of areas of known contamination. In addition, even during storm events Alternative 4 would prevent both the potential discharge of contaminated sediments known to exist at upgradient locations within the watershed and the mobilization of contaminated sediment during the performance of future remedial activities. Therefore, Alternative 4 would be effective in controlling sediment transport and would satisfy the RAOs.

Table 4.2. Removal action alternative comparisons

Criteria	Alternative 1 No Sediment Control Measures (No Action) Outfalls 001,008,010, 011, and 015	Alternative 2 Localized Controls and Integrated Controls Outfalls 001,010, and 015	Alternative 3 Localized Controls, Integrated Controls and System Controls (New Outfall Ditch) Outfalls 008 and 011	Alternative 4 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches and Sedimentation Basins) Outfalls 008 and 011
		Effectiveness		
RAOs	Does not meet **RAOs.**	Meets all RAOs.	Partially meets RAOs.	Meets all RAOs.
Overall Protection of Human Health and the Environment	Not protective.	Protective. • Provides an acceptable means of preventing sediment from leaving the site given the level of contamination present in the watersheds and planned remedial activities.	Partially Protective. • Provides an effective means of preventing sediment from leaving the site except during storm events.	Protective. • Provides an effective means of preventing sediment from leaving the site during both normal conditions and storm events.
Long-Term Effectiveness and Permanence	Not effective. • No institutional controls to protect against potential spread of contamination via runoff.	Effective and moderately permanent. • Sediment control methods are effective given the level of contamination present in the watersheds and planned remedial activities. • Integrated Controls are long-term measures.	Partially effective and moderately permanent. • Sediment control methods are effective except during storm events. • Integrated Controls and new ditch construction are long-term measures.	Effective and moderately permanent. • Sediment control methods are effective during both normal conditions and storm events. • Integrated Controls, new ditch construction, and sedimentation basins are long-term measures.
Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment	No reduction.	Sediment control measures using Localized Controls and Integrated Controls would provide partial reduction in mobility of sediment from Outfalls 001, 010, and 015.	Sediment control measures using Localized Controls, Integrated Controls, and new outfall ditches are effective at reducing the mobility of sediment except during storm events. New outfall ditches would reduce the overall volume of contaminated sediment available for transport.	Sediment control measures using Localized Controls, Integrated Controls, new outfall ditches, and sedimentation basins would be effective at reducing the mobility of sediment during both normal conditions and storm events. New outfall ditches would reduce overall volume of contaminated sediment available for transport.

Table 4.2. (continued)

Criteria	Alternative 1 No Sediment Control Measures (No Action) Outfalls 001,008,010, 011, and 015	Alternative 2 Localized Controls and Integrated Controls Outfalls 001,010, and 015	Alternative 3 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches) Outfalls 008 and 011	Alternative 4 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches and Sedimentation Basins) Outfalls 008 and 011
Short-Term Effectiveness	No short-term impacts.	Potential short-term impacts • Short-term potential for worker contact with PCBs, RCRA, and radioactive wastes during construction of Localized and Integrated Controls. Worker protection practices and procedures would minimize worker exposure to contaminated material during removal activities. • Short-term potential for spread of contamination via animal migration. Small mammal study, developed and implemented in 2001, will determine potential impacts. • Short-term potential for migration of contamination offsite via air emissions and fugitive dust. Controls, monitoring, and sampling would limit the spread of contamination due to air emissions and fugitive dust.	Potential short-term impacts. • Short-term potential for worker contact with PCBs, RCRA, and radioactive wastes during construction of Localized Controls, Integrated Controls, and excavation of new ditches at Outfalls 008 and 011. Worker protection practices and procedures would minimize worker exposure to contaminated material during removal activities. • Short-term potential for spread of contamination via animal migration. Small mammal study, developed and implemented in 2001, will determine potential impacts. • Short-term potential for migration of contamination offsite via air emissions and fugitive dust. Controls, monitoring, and sampling would limit the spread of contamination due to air emissions and fugitive dust.	Potential short-term impacts. • Short-term potential for worker contact with PCBs, RCRA, and radioactive wastes during construction of Localized Controls, Integrated Controls, new outfall ditches, and sedimentation basins. Worker protection practices and procedures would minimize worker exposure to contaminated material during removal activities. • Short-term potential for spread of contamination via animal migration. Small mammal study, developed and implemented in 2001, will determine potential impacts. • Short-term potential for migration of contamination offsite via air emissions and fugitive dust. Controls, monitoring, and sampling would limit the spread of contamination due to air emissions and fugitive dust.

Table 4.2. (continued)

Criteria	Alternative 1 No Sediment Control Measures (No Action) Outfalls 001,008,010, 011 and 015	Alternative 2 Localized Controls and Integrated Controls Outfalls 001,010, and 015	Alternative 3 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches) Outfalls 008 and 011	Alternative 4 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches and Sedimentation Basins) Outfalls 008 and 011
Implemerrtability				
Ability to Construct and Operate Technologies	Not applicable.	High. • Design, construction, and operation of Localized and Integrated Controls (rock check dams) can be accomplished using common industrial methods.	Medium. • Design, construction, and operation of Localized and Integrated Controls (rock check dams) can be accomplished using common industrial methods. • Excavation of new drainage ditches can be accomplished using common industrial methods.	Medium. • Design, construction, and operation of Localized and Integrated Controls (rock check dams) can be accomplished using common industrial methods. • Excavation of new drainage ditches can be accomplished using common industrial methods. • Design, construction, and operation of a sedimentation basin using gravity settling can be accomplished using common industrial methods.
Availability and Reliability of Technologies	Not applicable.	Medium. • Localized and Integrated Controls as means of controlling sediment transport are proven and commonly applied technologies.	Low. • Localized and Integrated Controls as means of controlling sediment transport are proven and commonly applied technologies. • Excavation of new drainage ditches is not a proven technology to control sediment transport.	Medium. • Localized and Integrated Controls as means of controlling sediment transport are proven and commonly applied technologies. • Excavation of new drainage ditches is not a proven technology to control sediment transport. • Sedimentation basins using gravity settling for the control of sediment transport is proven and commonly applied technology.
Availability of Treatment, Storage, and Disposal Services and Capacity	Not applicable.	Not applicable	Not applicable	Not applicable

Table 4.2. (continued)

Criteria	Alternative 1 No Sediment Control Measures (No Action) Outfalls 001, 008,010, 011, and 015	Alternative 2 Localized Controls and Integrated Controls Outfalls 001,010, and 015	Alternative 3 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches) Outfalls 008 and 011	Alternative 4 Localized Controls, Integrated Controls and System Controls (New Outfall Ditches and Sedimentation Basins) Outfalls 008 and 011
Capital Cost	All Outfalls: $0	Outfalls 001, 010, and 015: $69,842"	Outfall 008: $1,159,657 Outfall 011: $1,288,917	Outfall 008: $2,950,935 Outfall 011: $2,172,159
O&M Cost (30 years)	All Outfalls: $0	Outfalls 001, 010, and 015: $317,936"	Outfall 008: $333,836 Outfall 011: $333,836	Outfall 008: $1,970,302 Outfall 011: $1,811,302
Total Cost	All Outfalls: $0	Outfalls 001, 010, and 015: $387,778"	Outfall 008: $1,493,493 Outfall 011: $1,622,753	Outfall 008: $4,921,237 Outfall 011: $3,983,461

" Total cost for 5 rock check dams at each of the 3 outfalls.

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4.4.2 Implementability

All of the alternatives considered can be implemented at the PGDP. The No Sediment Control Measures Alternative would rank highest in implementability, since it requires no further work. Alternative 2, Localized and Integrated Controls, and Alternative 3, Localized Controls, Integrated Controls and System Controls (New Outfall Ditch), respectively, would be more difficult to implement due to associated construction and monitoring activities, but there are no impediments to implementation of either alternative because the technology required for either is readily available. Alternative 4, Localized Controls, Integrated Controls, System Controls (New Outfall Ditch and Sediment Control Basin), additionally would require the construction of a sediment basin at both outfall 008 and 011 and the construction of pumping systems at Outfall 008, which would make this alternative the most difficult to implement.

4.4.3 cost

Table 4.2 presents the capital cost, annual O&M cost, and the total cost for all of the alternatives. Detailed cost information for the removal action alternatives is presented in Appendix B. The No Sediment Control Measures (No Action) alternative would be the least expensive to implement. Alternative 2, Localized Controls and Integrated Controls (e.g., Rock Check Dams), and Alternative 3, Localized Controls, Integrated Controls, and Systems Controls (New Outfall Ditches), would be the second and third most expensive alternatives to implement, respectively. Alternative 4, Localized Controls, Integrated Controls and System Controls (New Outfall Ditches and Sedimentation Basin), would be the most expensive alternative to implement.

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5. RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the technology screening performed by the SWSC PCT (see Section 1.2) and the comparative analysis discussed in Section 4 of this document, Alternative 2, Localized Controls and Integrated Controls, is the recommended removal action alternative for Outfalls 001, 010, and 015 and Alternative 4, Localized Controls, Integrated Controls, System Controls (New Outfall Ditch and Sedimentation Control Basin), is the recommended removal action alternative for Outfalls 008 and 011. The alternative evaluation conducted for this removal action included consideration of the relative effectiveness, implementability, and cost of each propose alternative, and consideration of whether or not the alternative meets the RAOs.

Within the watersheds of Outfalls 001, 010, and 015, the existing levels of contamination are typically below human health risk levels of 1×10^{-4} for a child recreator. Discharge of contaminated sediments at these outfalls was not identified as a problem by the SWSC PCT. However, future remedial activities within these watersheds could create the potential for the discharge of contaminated sediment. Implementation of Alternative 2, which would include a combination of Localized and Integrated Controls at Outfalls 001, 010, and 015, would minimize sediment transport and prevent potential discharge of contaminated sediments from these outfalls during performance of future remedial activities. The proposed technologies provide commonly used, proven, cost-effective methods to achieve the RAOs at these outfalls.

Costs to implement Alternative 2 at Outfalls 001, 010, and 015 would include capital costs for construction and site restoration) and O&M costs for periodic site maintenance and cleanouts. Capital costs for implementation of this alternative these for three outfalls are estimated at $69,842; O&M costs for 30 years are estimated at $317,936.

Within the watersheds of Outfalls 008 and 011, levels of contamination are present at concentrations that exceed human health **risk** levels of 1×10^{-4} for a child recreator. Discharge of contaminated sediments at these outfalls was identified as a problem by the SWSC PCT. In addition, future remedial activities within these watersheds could create the potential for the additional discharge of contaminated sediment. Implementation of Alternative 4, which would include a combination of Localized Controls, Integrated Controls, abandonment of contaminated outfall ditches, excavation of new outfall ditches, and construction of sedimentation basins at Outfalls 008 and 011, would minimize sediment transport and prevent potential discharge of contaminated sediments from these outfalls now and during performance of future remedial activities. The proposed technologies provide commonly used, proven, cost-effective methods to achieve the RAOs at these outfalls.

Costs to implement Alternative 4 at Outfalls 008 and 011 would include capital costs for construction and site restoration and O&M costs for periodic site maintenance. Capital costs for implementation of this alternative at Outfall 008 are estimated at $2,950,935; O&M costs for 30 years are estimated at $1,970,302. Capital costs for implementation of this alternative at Outfall 011 are estimated at $2,172,159; O&M costs for 30 years at Outfall 011 are estimated at $1,811,302. Line item summaries of the individual elements included in these cost estimates are presented in Appendix B. Conceptual basin designs were developed and are included as Figures B.1 and B.2 in Appendix B.

The sediment control measures implemented under each of these alternatives would be monitored, both quantitatively and qualitatively, to ensure that they are performing as expected. Details of the proposed monitoring plan will be presented in the SWSC RAWP.

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6. REFERENCES

BJC (Bechtel Jacobs Company LLC) 2000. *Paducah Site Annual Environmental Report for 1998,* BJC/PAD-98, Kevil, KY, February.

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

CDM 2000. *Drum Mountain Small Mammal Sampling, March 2000, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* BJC/PAD 184/V2, July 2000.

CDM 2001. *Scrap Yards Small Mammals Sampling Project Report, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* BJC/PAD 303, November 2001.

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 1991.

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

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

Clausen, J. L., Davis, K. R., Douthitt, J. W., and Phillips, B. E. 1992b. *Report of the Paducah Gaseous Diffusion Plant Groundwater Protection Program Plan,* KY/ER-2, Rev. 1. Paducah, KY.

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 11: Threatened and Endangered Species Investigation,* United States Army Corps of Engineers, Nashville, TN, May.

COE 1994c. *Environmental Investigations at the Paducah Gaseous Diflusion 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 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 1993a. *Report for Environmental Audit Supporting Transition of the Gaseous Diffusion Plants to the United States Enrichment Corporation,* DOE/OR-1087&D4, United States Department of Energy, June.

DOE 1993b. *Remedial Investigation Addendum for WAG 22 Burial Grounds at Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1141&D1.

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

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

DOE 1997. *Action Memorandum for Waste Area Group 23 and Solid Waste Management Unit I of Waste Area Group 27, PCB Sites, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/06-1626&D1.

DOE 1998a. *Waste Area Grouping 6 Remedial Investigation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1727/V1&D1, Paducah, KY.

DOE 1998b. *Community Relations Plan for the Environmental Management and Enrichment Facilities Program,* DOE/OR/07-1233&D3, U.S. Department of Energy, Paducah, KY.

DOE 2000a. *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D1N1/R0.

DOE 2000b. *Methods for Designing and Conducting Ecological Risk Assessments and Risk Evaluations at Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506/V2&D1/R1.

DOE 2001. *Engineering Evaluation/Cost Analysis for Scrap Metal Disposition at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1880&D2/R1.

EPA (U.S. Environmental Protection Agency) 1992. *Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices,* EPA-832-R92-005, September.

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.

KDFWR 2000. Mist Net Surveys for the Indiana Bat *(Myotis sodalis)* at West Kentucky Wildlife Management Area, Paducah, Kentucky, Kentucky Department of Fish and Wildlife Resources, February.

Milne, G.N. 1997. *1996 Summary of Actions to Eliminate/Minimize Polychlorinated Biphenyl (PCB) Effluent Releases at the Paducah Gaseous Diffusion Plant,* KY/EM-125 R1, Paducah, KY.

SAIC (Science Applications International Corporation) 2001. Correspondence to Lance Fleming of BJC to transmit SWSC PCT Binning Packages for Outfalls 001,008,010,011, and 015, December 18.

TCT-St. Louis 1991. *Final Project Report of the Phase I Contamination Evaluation at Former Kentucky Ordnance Works, McCracken County, Kentucky,* Paducah, KY.

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

RISK TABLES

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Table A.l. Chemicals and compounds detected in soil and sediment a Outfall 001 at concentrations exceeding human health screening levels"

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
PCB-1248	mg/kg	29	0/96	1/96	42.5	28.3
PCB-1254	mg/kg	292	1/99	1/99	18.2	7.81
PCB-1260	mg/kg	370	2/99	3/99	42.5	28.3
Polychlorinated biphenyl	mg/kg	330	1/53	1/53	42.5	28.3
Cesium-137	pCi/g	51	4/32	3/32	10.5	21.8
Neptunium-237	pCi/g	60	1/47	0/47	45.4	95.3
Uranium-238	pCi/g	314	2/34	0/34	313	660

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level'	Industrial Worker No Action Level[e]	Child Recreator No Action Level'
Aluminum	mg/kg	17,500	24/25	25/25	4,640	1,980
Antimony	mg/kg	2.9	6/25	6/25	0.379	0.161
Arsenic	mg/kg	130	37/37	37/37	0.523	0.346
Barium	mg/kg	1,140	5/36	23/36	229	97.8
Beryllium	mg/kg	13.7	9/25	22/25	0.948	0.404
Chromium	mg/kg	80.8	36/37	36/37	2.84	1.21
Iron	mg/kg	54,000	25/25	25/25	2,070	883
Lead	mg/kg	51.5	2/37	2/37	50	50
Manganese	mg/kg	4,150	23/25	24/25	86.6	37
Silver	mg/kg	83.3	1/37	2/37	41.1	17.5
Uranium	mg/kg	6,500	39/66	44/66	101	43.4
Vanadium	mg/kg	80.7	22/25	24/25	3.32	1.42
Benz(a)anthracene	mg/kg	3.7	6/36	7/36	0.212	0.133
Benzo(a)pyrene	mg/kg	4	9/36	9/36	0.0212	0.0133
Benzo(b)fluoranthene	mg/kg	5.8	9/36	10/36	0.212	0.133
Benzo(k)fluoranthene	mg/kg	2.2	1/36	2/36	2.12	1.33
Indeno(1,2,3-cd)pyrene	mg/kg	2.5	4/36	6/36	0.212	0.133
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	0.0126	3/9	5/9	0.00619	0.00415
PCB-1248	mg/kg	29	3/96	3/96	0.199	0.127
PCB-1254	mg/kg	292	4/99	4/99	0.199	0.122
PCB-1260	mg/kg	370	33/99	39/99	0.199	0.127
Pentachloro-dibenzo[b,e][1,4]dioxin	mg/kg	0.00106	1/6	1/6	0.0000124	0.00000829
Polychlorinated biphenyl	mg/kg	330	19/53	19/53	0.199	0.127
Americium-241	PCi/g	9.43	1/33	0/33	8.09	20.5
Cesium-137	pCi/g	51	11/32	8/32	0.105	0.218

Table A.l. (continued)

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level'	Industrial Worker No Action Level[e]	Child Recreator No Action Level'
Neptunium-237	pCi/g	63	13/47	12/47	0.454	0.953
Plutonium-239	pCi/g	240	10/40	6/40	10.1	26.8
Technetium-99	pCi/g	3,900	2/59	0/59	2,270	6,030
Thorium-230	pCi/g	1,300	7/45	5/45	83.4	220
Uranium-234	pCi/g	150	4/34	0/34	71.3	189
Uranium-235	pCi/g	12	13/33	9/33	0.816	1.7
Uranium-238	pCi/g	314	25/34	22/34	3.13	6.6

[a] Information presented in this table taken from Outfall 001 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah. Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of $1 \times 10''$ or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure Frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure fiequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

Table A.2. Chemicals and compounds detected in surface water at Outfall 001 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Industrial Worker Action Level[c]	Child Recreator Action Level[d]	Industrial Worker Action Level[e]	Child Recreator Action Level[f]
None	—	—	—	—	—	—
			Freauencv of Detection[b] above			
Chemical or Compound	**Units**	**Maximum Detect**	**Industrial Worker No Action Level[e]**	**Child Recreator No Action Level[f]**	**Industrial Worker No Action Level[e]**	**Child Recreator No Action Level[f]**
Antimony	mg/L	7.50E-03	1/23	3/23	7.31E-03	3.12E-03
Cadmium	mg/L	2.10E-02	1/29	1/29	4.57E-03	1.95E-03
Chromium	mg/L	4.05E-02	0/23	1/23	5.48E-02	2.34E-03
PCB-1248	mg/L	2.00E-04	1/35	1/35	1.56E-04	9.09E-05
PCB-1254	mg/L	1.70E-04	2/35	2/35	4.70E-05	2.00E-05
PCB-1260	mg/L	1.70E-04	2/35	2/35	5.24E-05	3.06E-05
Polychlorinated biphenyl	mg/L	2.00E-04	5/38	5/38	1.65E-04	9.61E-05

[a] Information presented in this table taken from Outfall 001 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Difusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

[f] No action levels ***taken*** from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Difusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 001; therefore, this is a conservative comparison.

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Table A.3. Chemicals and compounds detected in soil and sediment at Outfall 008 at concentrations exceeding human health screening levels'

Chemical or Compound	Units	Maximum Detect	Frequencey of Detection[b] above Industrial Worker Action Level'	Frequencey of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level'	Child Recreator Action Level[d]
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	1.43E-03	1/7	1/7	6.19E-04	4.15E-04
Benzo(a)pyrene	mg/kg	1.60E+01	0/77	1/77	2.08E+01	1.46E+01
PCB-1242	mg/kg	3.80E+01	0/162	1/162	4.25E+01	2.83E+O1
PCB-1248	mg/kg	3.50E+01	0/160	1/160	4.25E+O1	2.83E+01
PCB-1254	mg/kg	1.43E+02	2/167	2/167	1.82E+01	7.81E+O1
Polychlorinated biphenyl	mg/kg	1.43E+02	1/56	1/56	4.25E+01	2.83E+01

Chemical or Compound	Units	Maximum Detect	Freauencev of Detection[b] above Industrial Worker No Action Level[e]	Freauencev of Detection[b] above Child Recreator No Action Level'	Industrial Worker No Action Level[e]	Child Recreator No Action Level'
Aluminum	mg/kg	1.42E+04	76/87	87/87	4.64E+03	1.98E+03
Antimony	mg/kg	4.00E+00	20/82	20/82	3.79E-01	1.61E-01
Arsenic	mg/kg	4.52E+01	83/99	83/99	5.23E-01	3.46E-01
Barium	mg/kg	2.80E+02	3/99	34/99	2.29E+02	9.78E+01
Beryllium	mg/kg	1.54E+01	9/87	61/87	9.48E-01	4.04E-01
Chromium	mg/kg	2.58E+02	98/99	98/99	2.84E+00	1.21E+00
Copper	mg/kg	2.81E+02	0/87	2/87	4.93E+02	2.11E+02
Iron	mg/kg	4.85E+04	87/87	87/87	2.07E+03	8.83E+02
Lead	mg/kg	3.23E+02	3/99	3/99	5.00E+01	5.00E+01
Manganese	mg/kg	2.39E+03	85/87	86/87	8.66E+01	3.70E+01
Mercury	mg/kg	7.70E+00	5/99	8/99	9.82E-01	4.19E-01
Nickel	mg/kg	1.16E+02	0/99	2/99	2.42E+02	1.03E+02
Silver	mg/kg	4.25E+01	1/99	1/99	4.11E+01	1.75E+01
Vanadium	mg/kg	9.72E+01	86/87	86/87	3.32E+00	1.42E+00
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	1.43E-03	2/7	2/7	6.19E-06	4.15E-06
Benz(a)anthracene	mg/kg	1.80E+01	17/77	18/77	2.12E-01	1.33E-01
Benzo(a)pyrene	mg/kg	1.60E+01	20/77	21/77	2.12E-02	1.33E-02
Benzo(b)fluoranthene	mg/kg	1.70E+01	19/77	19/77	2.12E-01	1.33E-01
Benzo(k)fluoranthene	mg/kg	1.10E+01	7/77	7/77	2.12E+00	1.33E+00
Chrysene	mg/kg	1.90E+01	0/77	2/77	2.12E+01	1.33E+01
Dibenz(a,h)anthracene	mg/kg	3.20E+00	6/77	6/77	2.12E-02	1.33E-02
Heptachloro-dibenzo[b,e][1,4]dioxin	mg/kg	5.35E-03	1/10	1/10	6.19E-04	4.15E-04
Indeno(1,2,3-cd)pyrene	mg/kg	5.80E+00	11/77	13/77	2.12E-01	1.33E-01
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	3.93E-02	1/10	2/10	6.19E-03	4.15E-03
PCB-1242	mg/kg	3.80E+01	5/162	5/162	1.99E-01	1.27E-01
PCB-1248	mg/kg	3.50E+01	7/160	16/160	1.99E-01	1.27E-01

Table A.3. (continued)

Chemical or Compound	Units	Maximum Detect	Frequencey of Detection[b] above Industrial Worker No Action Level[e]	Frequencey of Detection[b] above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
PCB-1254	mg/kg	1.43E+02	14/167	141167	1.99E-01	1.22E-01
PCB-1260	mg/kg	1.10E+01	191166	201166	1.99E-01	1.27E-01
Polychlorinated biphenyl	mg/kg	1.43E+02	16/56	16/56	1.99E-01	1.27E-01
Vinyl chloride	mg/kg	2.70E-01	1/60	1/60	1.34E-01	9.54E-02
Cesium-137	pCi/g	1.50E+00	7/21	4121	1.05E-01	2.18E-01
Neptunium-237	pCi/g	1.22E+01	6/40	3/40	4.54E-01	9.53E-01
Plutonium-239	pCi/g	1.30E+01	1/29	0129	1.01E+01	2.68E+01
Thorium-228	pCi/g	1.40E+00	212	212	3.52E-02	7.33E-02
Thorium-230	pCi/g	1.88E+02	1/38	0/38	8.34E+01	2.20E+02
Uranium-234	PCi/g	7.60E+01	1/66	0166	7.13E+01	1.89E+02
Uranium-235	pCi/g	4.00E+00	3160	2160	8.16E-01	1.70E+00
Uranium-238	pCi/g	1.20E+02	20166	12/66	3.13E+00	6.60E+00

[a] Information presented in this table taken from Outfall 008 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah. Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

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Table A.4. Chemicals and compounds detected in surface water at Outfall 008 at concentrations exceeding human health screening levels'

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
None	—	—	—	—	—	—

Chemical or Compound	Units	Maximum Detect	Frequency of Detection above Industrial Worker No Action Level[e]	Frequency of Detection above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
Antimony	mg/L	4.10E-03	0/22	2/22	7.31E-03	3.12E-03

[a] Information presented in this table taken from Outfall 008 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure fiequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conductirig Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

[f] No action levels ***taken*** from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 008; therefore, this is a conservative comparison.

Table A.5. Chemicals and compounds detected in soil and sediment at Outfall 010 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
None	—	—	—	—	—	—

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level[c]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[c]
Aluminum	mg/kg	1.29E+04	27/31	30/31	4.64E+03	1.98E+03
Antimony	mg/kg	1.10E+00	5/31	5/31	3.79E-01	1.61E-01
Arsenic	mg/kg	1.95E+01	21/33	21/33	5.23E-01	3.46E-01
Barium	mg/kg	1.61E+02	0/33	5/33	2.29E+02	9.78E+01
Beryllium	mg/kg	4.60E+00	5/31	14/31	9.48E-01	4.04E-01
Chromium	mg/kg	9.04E+01	33/33	33/33	2.84E+00	1.21E+00
Iron	mg/kg	4.19E+04	31/31	31/31	2.07E+03	8.83E+02
Manganese	mg/kg	8.78E+02	28/31	31/31	8.66E+01	3.70E+01
Vanadium	mg/kg	7.55E+01	31/31	31/31	3.32E+00	1.42E+00
Benz(a)anthracene	mg/kg	1.30E+00	3/6	4/6	2.12E-01	1.33E-01
Benzo(a)pyrene	mg/kg	2.40E+00	4/6	4/6	2.12E-02	1.33E-02
Benzo(b)fluoranthene	mg/kg	5.00E+00	4/6	4/6	2.12E-01	1.33E-01
Dibenz(a,h)anthracene	mg/kg	1.00E-01	1/6	1/6	2.12E-02	1.33E-02
Indeno(1,2,3-cd)pyrene	mg/kg	1.30E+00	2/6	2/6	2.12E-01	1.33E-01
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	2.53E-02	3/5	4/5	6.19E-03	4.15E-03
PCB-1016	mg/kg	1.87E+00	1/47	1/47	1.99E-01	1.27E-01
PCB-1254	mg/kg	3.00E-01	3/55	3/55	1.99E-01	1.22E-01
PCB-1260	mg/kg	1.40E+00	9/55	9/55	1.99E-01	1.27E-01
Polychlorinated biphenyl	mg/kg	1.40E+00	4/24	4/24	1.99E-01	1.27E-01
Cesium-137	pCi/g	1.90E+00	1/8	1/8	1.05E-01	2.18E-01
Neptunium-237	pCi/g	1.28E+01	1/4	1/4	4.54E-01	9.53E-01
Technetium-99	pCi/g	2.65E+03	1/30	0/30	2.27E+03	6.03E+03
Uranium-238	pCi/g	5.17E+01	13/22	7/22	3.13E+00	6.60E+00

[a] Information presented in this table taken from Outfall 010 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

Table A.5. (continued)

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

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Table A.6. Chemicals and compounds detected in surface water at Outfall 010 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
None	—	—	—	—	—	—

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
Antimony	mg/L	8.00E-03	1/24	4/24	7.31E-03	3.12E-03
Chromium	mg/L	2.89E-02	0124	1/24	5.48E-02	2.34E-03
Vanadium	mg/L	2.92E-02	0/24	1/24	6.40E-02	2.73E-02
Bis(2-ethylhexyl)phthalate	mg/L	1.1OE-02	014	1/4	1.51E-02	8.82E-03

[a] information presented in this table taken from Outfall 010 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Difusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Difusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

[f] No action levels ***taken*** from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Difusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, I2 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 010; therefore, this is a conservative comparison.

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Table A.7. Chemicals and compounds detected in soil and sediment at Outfall 011 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
Benzo(a)pyrene	mg/kg	1.13E+02	5/18	6/18	2.08E+01	1.46E+01
Dibenz(a,h)anthracene	mg/kg	7.10E+01	2/18	2/18	2.08E+01	1.46E+01
PCB-1248	mg/kg	1.08E+03	4/71	5/71	4.25E+01	2.83E+01
PCB-1254	mg/kg	8.36E+01	1/144	2/144	1.82E+01	7.81E+01
PCB-1260	mg/kg	4.75E+02	5/145	5/145	4.25E+01	2.83E+01
Pentachloro-dibenzo[b,e][1,4]dioxin	mg/kg	2.49E-02	1/6	1/6	4.25E+01	2.83E+01
Polychlorinated biphenyl	mg/kg	4.00E+01	0/38	1/38	4.25E+01	2.83E+01
Uranium-238	pCi/g	2.74E+03	3/11	2/11	3.13E+02	6.60E+02

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
Aluminum	mg/kg	1.54E+04	13/18	17/18	4.64E+03	1.98E+03
Arsenic	mg/kg	1.25E+01	4/18	4/18	5.23E-01	3.46E-01
Barium	mg/kg	1.48E+02	0/18	3/18	2.29E+02	9.78E+01
Beryllium	mg/kg	7.40E+00	5/18	9/18	9.48E-01	4.04E-01
Chromium	mg/kg	3.71E+02	18/18	18/18	2.84E+00	1.21E+00
Iron	mg/kg	2.43E+04	17/18	18/18	2.07E+03	8.83E+02
Lead	mg/kg	7.05E+01	3/18	3/18	5.00E+01	5.00E+01
Manganese	mg/kg	5.94E+02	16/18	18/18	8.66E+01	3.70E+01
Mercury	mg/kg	4.30E-01	0/18	1/18	9.82E-01	4.19E-01
Nickel	mg/kg	3.82E+02	1/18	3/18	2.42E+02	1.03E+02
Uranium	mg/kg	1.03E+03	10/12	12/12	1.01E+02	4.34E+01
Vanadium	mg/kg	6.50E+01	18/18	18/18	3.32E+00	1.42E+00
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	mg/kg	1.05E-04	1/5	1/5	6.19E-05	4.15E-05
Benz(a)anthracene	mg/kg	9.00E+01	13/18	13/18	2.12E-01	1.33E-01
Benzo(a)pyrene	mg/kg	1.13E+02	13/18	13/18	2.12E-02	1.33E-02
Benzo(b)fluoranthene	mg/kg	1.21E+02	12/18	13/18	2.12E-01	1.33E-01
Benzo(k)fluoranthene	mg/kg	9.30E+01	9/18	10/18	2.12E+00	1.33E+00
Chrysene	mg/kg	8.60E+01	5/18	6/18	2.12E+01	1.33E+01
Dibenz(a,h)anthracene	mg/kg	7.10E+01	4/18	4/18	2.12E-02	1.33E-02
Hexachloro-dibenzo[b,e][1,4]dioxin	mg/kg	3.36E-03	1/6	1/6	6.19E-04	4.15E-04
Hexachlorodibenzofuran	mg/kg	5.20E-03	1/6	1/6	6.19E-04	4.15E-04
Indeno(1,2,3-cd)pyrene	mg/kg	9.40E+01	12/18	12/18	2.12E-01	1.33E-01
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	1.60E-02	5/11	6/11	6.19E-03	4.15E-03
PCB-1242	mg/kg	1.00E+00	3/68	3/68	1.99E-01	1.27E-01

Table A.7. (continued)

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
PCB-1248	mg/kg	1.08E+03	13/71	13/71	1.99E-01	1.27E-01
PCB-1254	mg/kg	8.36E+01	21/144	21/144	1.99E-01	1.22E-01
PCB-1260	mg/kg	4.75E+02	48/145	53/145	1.99E-01	1.27E-01
Pentachloro-dibenzo[b,e][1,4]dioxin	mg/kg	2.49E-02	1/6	1/6	1.24E-05	8.29E-06
Polychlorinated biphenyl	mg/kg	4.00E+01	30/38	30/38	1.99E-01	1.27E-01
Pyrene	mg/kg	1.08E+02	0/18	1/18	1.65E+02	7.06E+01
Trichloroethene	mg/kg	5.34E+00	1/88	1/88	2.51E+00	1.80E+00
Cesium-137	pCi/g	1.58E-01	2/17	0/17	1.05E-01	2.18E-01
Uranium-234	pCi/g	3.79E+02	2/11	1/11	7.13E+01	1.89E+02
Uranium-235	pCi/g	4.90E+01	3/34	3/34	8.16E-01	1.70E+00
Uranium-238	pCi/g	2.74E+03	11/11	11111	3.13E+00	6.60E+00

[a] Information presented in this table taken from Outfall 011 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Hunian Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant. Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure Frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, exposure frequencies of 140 daysiyear as child and 104 daysiyear as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Hunian Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 daysiyear, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure Frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Hunian Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, exposure Frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

Table A.8. Chemicals and compounds detected in surface water at Outfall 011 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[e]	Child Recreator Action Level[d]
Lead	mg/L	2.04E-01	21100	21100	3.00E-02	3.00E-02

Chemical or Compound	Units	Maximum Detect	Freauencv of Detection[b] above Industrial Worker No Action Level[e]	Freauencv of Detection[b] above Child Recreator No Action Level[f]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
Cadmium	mg/L	2.00E-02	11100	11100	4.57E-03	1.95E-03
Chromium	mg/L	1.56E-01	51363	71363	5.48E-02	2.34E-02
Lead	mg/L	2.04E-01	31100	3/100	1.50E-02	1.50E-02
Manganese	mg/L	3.55E+00	1113	2113	1.68E+00	7.17E-01
Uranium	mg/L	4.40E+00	1/447	21447	2.33E+00	9.94E-01
cis-1,2-Dichloroethene	mg/L	4.20E-01	0122	1122	9.14E-01	3.90E-01
PCB-1248	mg/L	3.60E-04	1/7	217	1.56E-04	9.09E-05
PCB-1260	mg/L	1.30E-03	19/26	19/26	5.24E-05	3.06E-05
Polychlorinated biphenyl	mg/L	1.70E-03	191329	31/329	1.65E-04	9.61E-05
Trichloroethene	mg/L	2.20E-01	151175	271175	2.18E-02	1.27E-02

[a] information presented in this table taken from Outfall 011 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 011; therefore, this is a conservative comparison.

Table A.9. Chemicals and compounds detected in soil and sediment at Outfall 015 at concentrations exceeding human health screening levels'

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker Action Level[c]	Frequency of Detection[b] above Child Recreator Action Level[d]	Industrial Worker Action Level[c]	Child Recreator Action Level[d]
Cesium-137	pCi/g	5.23E+01	1/4	1/4	1.05E+01	2.18E+01

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above Industrial Worker No Action Level[e]	Frequency of Detection[b] above Child Recreator No Action Level[c]	Industrial Worker No Action Level[e]	Child Recreator No Action Level[c]
Aluminum	mg/kg	1.77E+04	9/9	9/9	4.64E+03	1.98E+03
Antimony	mg/kg	1.60E+00	3/9	3/9	3.79E-01	1.61E-01
Arsenic	mg/kg	4.63E+01	919	9/9	5.23E-01	3.46E-01
Barium	mg/kg	1.98E+02	019	8/9	2.29E+02	9.78E+01
Beryllium	mg/kg	2.12E+01	5/9	9/9	9.48E-01	4.04E-01
Chromium	mg/kg	3.68E+01	8/9	819	2.84E+00	1.21E+00
Iron	mg/kg	2.46E+04	919	9/9	2.07E+03	8.83E+02
Manganese	mg/kg	1.50E+03	8/9	8/9	8.66E+01	3.70E+01
Thallium	mg/kg	1.40E+00	2/9	3/9	7.27E-01	3.10E-01
Vanadium	mg/kg	7.01E+O1	9/9	9/9	3.32E+00	1.42E+00
Benz(a)anthracene	mg/kg	5.00E-01	1/12	1/12	2.12E-01	1.33E-01
Benzo(a)pyrene	mg/kg	4.70E-01	2/12	2/12	2.12E-02	1.33E-02
Benzo(b)fluoranthene	mg/kg	5.50E-01	1/12	2/12	2.12E-01	1.33E-01
Dibenz(a,h)anthracene	mg/kg	9.30E-01	1/12	1/12	2.12E-02	1.33E-02
Indeno(1,2,3-cd)pyrene	mg/kg	9.30E-01	1/12	1/12	2.12E-01	1.33E-01
PCB-1260	mg/kg	4.00E-01	1/11	1/11	1.99E-01	1.27E-01
Polychlorinated biphenyl	mg/kg	7.00E+00	12/93	12/93	1.99E-01	1.27E-01
Cesium-137	pCi/g	5.23E+01	314	3/4	1.05E-01	2.18E-01
Neptunium-237	pCi/g	1.22E+01	1/9	1/9	4.54E-01	9.53E-01
Thorium-230	pCi/g	1.88E+02	1/9	0/9	8.34E+01	2.20E+02
Uranium-238	pCi/g	1.40E+01	418	2/8	3.13E+00	6.60E+00

[a] Information presented in this table taken from Outfall 015 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah. Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

Table A.9. (continued)

[d] Action levels taken from App. A of draft ***Methods for Conducting Hunian Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

[f] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, exposure frequencies of 140 days/year as child and 104 days/year as a teen or adult, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates and vapors emitted by sediment, and external exposure to ionizing radiation emitted by radionuclides in sediment. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

Table A.lO. Chemicals and compounds detected in surface water at Outfall 015 at concentrations exceeding human health screening levels[a]

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above		Industrial Worker Action Level[c]	Child Recreator Action Level[d]
			Industrial Worker Action Level[c]	Child Recreator Action Level[d]		
None	—	—	—	—	—	—

Chemical or Compound	Units	Maximum Detect	Frequency of Detection[b] above		Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]
			Industrial Worker No Action Level[e]	Child Recreator No Action Level[f]		
Antimony	mg/L	3.80E-03	0/18	1/18	7.31E-03	3.12E-03
Arsenic	mg/L	4.70E-03	0/19	2/19	7.00E-03	4.09E-03
Cadmium	mg/L	2.60E-02	2/78	2/78	4.57E-03	1.95E-03
Iron	mg/L	2.30E+01	0/133	2/133	4.11E+01	1.75E+01
Lead	mg/L	2.74E-02	2/77	2/77	1.50E-02	1.50E-02
Uranium	mg/L	1.00E+00	0/95	1/95	2.33E+00	9.94E-01
Vanadium	mg/L	2.97E-02	0/7	1/7	9.14E-01	3.90E-01
Polychlorinated biphenyl	mg/L	1.00E-04	0/113	1/113	1.65E-04	9.61E-05

[a] information presented in this table taken from Outfall 015 "binning" table presented in SAIC 2001.

[b] Number of samples in which chemical or compound was detected above the action or no action level over the total number of samples.

[c] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

[d] Action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator action level derived using either a target cancer risk of 1×10^{-4} or a target hazard index of 3, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

[e] No action levels taken from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Industrial worker no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 0.1, an exposure frequency of 250 days/year, and an exposure duration of 25 years. The route of exposure included was dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

[f] No action levels ***taken*** from App. A of draft ***Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** (DOE 2000b). Child recreator no action level derived using either a target cancer risk of 1×10^{-6} or a target hazard index of 1, an exposure time of 2.6 hours/day, an exposure frequency of 45 days/year, and exposure durations of 6 years as child, 12 years as teen, and 22 years as an adult. Routes of exposure included were incidental ingestion of surface water and dermal contact with surface water. Note: the exposure frequency and duration used to derive the no action level exceeds that which can reasonably be expected to occur at Outfall 015; therefore, this is a conservative comparison.

Table A.11. Ecological No Further Action and Upper Screening Values for Sediment, Surface Water and Soil, PGDP, Paducah, Kentucky

Analyte	Sediment NFA Value[a]	Sediment Upper Screening Value[b]	Surface Water NFA Value[c]	Surface Water Upper Screening Value[d]	Soil NFA Value[e]	Soil Upper Screening Value[f]
Inorganics	**(mg/kg)**	**(mg/kg)**	**(µg/L)**	**(µg/L)**	**(mg/kg)**	**(mg/kg)**
Aluminum	2.55E+04	—	8.70E+01	7.50E+02	5.00E+00	5.00E+04
Ammonia as Nitrogen	—	—	—	—	—	—
Antimony	2.00E+00	—	1.60E+02	1.80E+02	1.90E+00	3.50E+03
Arsenic	5.90E+00	1.70E+01	5.00E+01	—	1.00E+00	1.70E+01
Arsenic (111)	—	—	1.90E+02	3.40E+02	—	—
Arsenic (V)	—	—	3.10E+00	6.60E+01	—	—
Barium	—	—	4.00E+00	1.10E+02	2.00E+01	9.09E+01
Beryllium	—	—	5.30E-01	3.50E+01	1.90E-01	3.03E+01
Biochemical Oxygen Demand (BOD)	—	—	—	—	—	—
Boron	—	—	7.50E+02	3.00E+01	5.00E-01	5.00E+02
Cadmium	2.70E-01	3.53E+00	1.42E+00	2.06E+00	1.10E-01	3.53E+00
Calcium	—	—	—	—	—	—
Calcium hardness	—	—	—	—	—	—
Chemical Oxygen Demand (COD)	—	—	—	—	—	—
Chloride	—	—	6.00E+05	1.20E+06	—	—
Chlorine, Total Residual	—	—	1.10E+01	1.90E+01	—	—
Chromium	3.73E+01	9.00E+01	4.89E+01	1.02E+03	4.00E-01	9.00E+01
Chromium (VI)	—	—	1.10E+01	1.60E+01	4.00E-02	—
Cobalt	—	—	2.30E+01	1.50E+03	2.50E+00	2.00E+04
Copper	3.00E+01	1.49E+02	5.16E+00	7.28E+00	4.50E-01	1.49E+02
Cyanide	—	—	5.20E+00	2.20E+01	9.00E-01	9.00E+02
Dissolved Solids	—	—	—	—	—	—
Fluoride	—	—	—	—	—	—
Hardness - Total as CaCO3	—	—	—	—	—	—
Iron	2.00E+03	—	1.00E+03	4.00E+03	1.10E+02	2.00E+05
Kjeldahl Nitrogen	—	—	—	—	—	—
Lead	1.20E+01	9.13E+01	1.32E+00	3.38E+01	2.00E+01	9.13E+01
Lithium	—	—	—	2.60E+02	2.00E+00	2.00E+03
Magnesium	—	—	—	—	—	—
Manganese	6.14E+02	—	1.20E+02	2.30E+03	2.50E+01	1.00E+05
Mercury	1.60E-01	4.86E-01	1.20E-02	1.70E+00	1.00E-01	2.53E-02
Molybdenum	—	—	3.70E+02	1.60E+04	2.00E+00	2.00E+03
Nickel	1.60E+01	3.60E+01	2.90E+01	2.61E+02	1.10E+01	3.60E+01
Nitrate as Nitrogen	—	—	—	—	—	—
Nitrate/Nitrite	—	—	—	—	—	—
Oil and Grease	—	—	—	—	—	—
pH	—	—	—	—	—	—
Phosphorous	—	—	—	—	—	—
Potassium	—	—	—	—	—	—
Selenium	5.00E-02	—	5.00E+00	2.00E+01	2.10E-01	1.52E+00
Silicon	—	—	—	—	—	—
Silver	3.80E-04	—	1.20E-02	1.23E+00	1.00E+00	2.00E+03
Sodium	—	—	—	—	—	—
Strontium	—	—	1.50E+03	1.50E+04	—	—

Table A.11. Ecological No Further Action and Upper Screening Values for Sediment, Surface Water and Soil, PGDP, Paducah, Kentucky (continued)

Analyte	Sediment NFA Value[a]	Sediment Upper Screening Value[b]	Surface Water NFA Value[c]	Surface Water Upper Screening Value[d]	Soil NFA Value[e]	Soil Upper Screening Value[f]
Sulfate	—	—	—	—		
Sulfide	—	—	2.00E+00	—	—	—
Suspended Solids	—	—	—	—	—	—
Technetium	—	—	—	—	2.00E-01	2.00E+02
Thallium	—	—	4.00E+00	1.10E+02	1.00E+00	1.00E+03
Tin	—	—	7.30E+01	2.70E+03	5.60E+00	5.30E+04
Titanium	—	—	—	—	1.00E+03	1.00E+06
Total Orgainic Carbon (TOC)	—	—	—	—	—	—
Total Phosphate as Phosphorus	—	—	—	—	—	—
Uranium	—	—	2.60E+00	4.60E+01	5.00E+00	2.81E+01
Vanadium	2.00E-01	—	2.00E+01	2.80E+02	2.00E+00	2.00E+03
Zinc	4.70E+00	3.15E+02	6.70E+01	6.65E+01	8.50E+00	3.15E+02
Organics						
Acenaphthene	8.90E-02	—	1.70E+01	8.00E+01	2.00E+01	1.77E+03
Acenaphthylene	—	—	—	—	—	—
Acetone	9.10E-02	—	1.50E+03	2.80E+04		
Aldrin	—	—	3.00E-01	3.00E+00	2.50E-03	2.50E+00
Aliphatic chlorinated hydrocarbons (total)	—	—	—	—	1.00E-01	1.00E+02
Anthracene	2.30E+01	8.45E-01	7.30E-01	1.30E+01	1.00E-01	8.45E-01
1,2-Benzenedicarboxylic acid	—	—	—	—	—	—
Benzo(a)anthracene	3.17E-02	3.85E-01	2.70E-02	4.90E-01		3.85E-01
Benzene	5.70E-02	—	5.30E+01	2.30E+03	5.00E-02	5.00E+01
Benzo(a)pyrene	3.19E-02	7.82E-01	1.40E-02	2.40E-01	1.00E-01	7.82E-01
Benzo(b)fluoranthene	4.00E-03	—	—	—	—	—
Benzo(ghi)perylene	—	—	—	—	—	—
Benzo(k)fluoranthene	4.00E-03	—	—	—	—	—
BHC-delta	—	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	1.80E-02	—	1.20E-01	2.70E+01	—	—
Biphenyl	—	—	—	—	6.00E+01	6.00E+04
Bromodichloromethane	—	—	—	—	—	—
1,3,5-Cycloheptatriene	—	—	—	—	—	—
Carbazole	—	—	—	—	—	—
Carbon disulfide	8.60E-04	—	9.20E-01	1.70E+01	—	—
Chlordane-alpha	—	—	—	—	—	—
Chlordane-gamma	—	—	—	—	—	—
Chlorinated hydrocarbons (total)	—	—	—	—	1.00E-01	1.00E+02
Chloroform	9.60E-02	—	2.89E+02	4.90E+02	1.00E-03	1.00E+00
Chrysene	3.30E-02	8.62E-01	—	—	—	8.62E-01
Cresols (Total)	—	—	—	—	5.00E-01	—
Cyclic Aromatic Hydrocarbons (Total)	—	—	—	—	1.00E-01	1.00E+02
1,2-Dichloroethane	4.30E-02	—	2.00E+03	8.80E+03	4.00E-01	4.00E+02
1,1-Dichloroethene	3.50E-02	—	3.03E+02	3.20E+00	—	—
1,2-Dichloroethene	—	—	5.90E+02	1.10E+03	—	—
cis-1,2-Dichloroethene	—	—	—	—	—	—
2,4-Dimethylphenol	—	—	2.12E+01	—	—	—
3,5-Dimethylheptane	—	—	—	—	—	—
Dibenz(a,h)anthracene	1.00E-02	—	—	—	—	—
Di-n-butyl phthalate	—	—	9.40E+00	1.90E+02	2.00E+02	2.00E+05

Table A.11. Ecological No Further Action and Upper Screening Values for Sediment, Surface Water and Soil, PGDP, Paducah, Kentucky (continued)

Analyte	Sediment NFA Value[a]	Sediment Upper Screening Value[b]	Surface Water NFA Value[c]	Surface Water Upper Screening Value[d]	Soil NFA Value[e]	Soil Upper Screening Value[f]
Diethyl phthalate	6 1OE-02	—	5.2 1E+02	1.80E+03	1.00E+02	1.00E+05
Di-n-octylphthalate	—	—	—	—	—	—
Dibenzofuran	—	—	3.70E+00	6.60E+01	—	—
Dichlorodifluoromethane	—	—	—	—	—	—
Dioxins, total equivalent	2.50E-06	—	—	—	—	—
Endrin ketone	—	—	—	—	—	—
Ethylbenzene	5.40E-01	—	4.53E+02	1.30E+02	5.00E-02	5.00E+01
Fluoranthene	5.40E-02	2.23E+00	3.98E+01	3.36E+01	1.00E-01	2.23E+00
Fluorene	1.00E-02	5.36E-01	—	7.00E+01	—	5.36E-01
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	—	—	—	—	—	—
1,2,3,4,6,7,8-Hexachlorodibenzofuran	—	—	—	—	—	—
1,2,3,4,7,8,9-Heptachlorodibenzofuran	—	—	—	—	—	—
1,2,3,4,7,8-Hexachlorodibenzofuran	—	—	—	—	—	—
1,2,3,6,7,8-Hexachlorodibenzofuran	—	—	—	—	—	1.62E-03
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	—	—	—	—	—	—
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	—	—	—	—	—	—
1,2,3,7,8,9-Hexachlorodibenzofuran	—	—	—	—	—	—
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	—	—	—	—	—	—
2,2',3,4',5',6-Hexachloro-1,1'-biphenyl	—	—	—	—	—	—
2,3,4,6,7,8-Hexachlorodibenzofuran	—	—	—	—	—	—
2,5-Hexanedione	—	—	—	—	—	—
Heptachloro-dibenzo[b,e][1,4]dioxin	—	—	—	—	—	—
Hexachlorobiphenyl	—	—	—	—	—	—
Hexachloro-dibenzo[b,e,][1,4]dioxin	—	—	—	—	—	—
Hexachlorodibenzofuran	—	—	—	—	—	—
Hexadecanoic acid	—	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	1.70E-02	—	—	—	—	—
1-Methyl-2-propylcyclohexane	—	—	—	—	—	—
1-Methylnaphthalene	—	—	2.10E+00	3.70E+01	—	—
2-Methylnaphthalene	—	—	—	—	—	—
3- and 4- Methylphenol	—	—	—	—	—	—
4-Methyl-3-penten-2-one	—	—	—	—	—	—
4-Methylphenol	—	—	—	—	—	—
Methyl Isobutyl Carbinol	—	—	—	—	—	—
Methylene chloride	—	—	1.93E+03	2.60E+04	—	—
Naphthalene	1.46E-02	5.61E-01	6.20E+01	1.90E+02	1.00E-01	5.61E-01
1-Octadecene	—	—	—	—	—	—
Octadecene	—	—	—	—	—	—
Octachlorodibenzo[b,e][1,4]dioxin	—	—	—	—	—	—
Octachlorodibenzofkan	—	—	—	—	—	—
Octathiocane	—	—	—	—	—	—
Organochlorinated pesticides (total)	—	—	—	—	1.00E-01	1.00E+02
1,2,3,7,8-Pentachlorodibenzofuran	—	—	—	—	—	1.62E-03
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	—	—	—	—	—	—
2,3,4,7,8-Pentachlorodibenzofuran	—	—	—	—	—	6.36E-05
2-Propanol	—	—	7.50E+00	1.30E+02	—	—
3-Penten-2-one	—	—	—	—	—	—
PAHs (Total)	1.61E+00	2.28E+01	—	—	1.00E+00	1.01E+01
PCBs (Total)	3.20E-02	2.77E-01	1.40E-03	2.00E+00	2.00E-02	1.18E-01

Table A.11. Ecological No Further Action and Upper Screening Values for Sediment, Surface Water and Soil, PGDP, Paducah, Kentucky (continued)

Analyte	Sediment NFA Value[a]	Sediment Upper Screening Value[b]	Surface Water NFA Value[c]	Surface Water Upper Screening Value[d]	Soil NFA Value[e]	Soil Upper Screening Value[f]
PCB-1016	—	—	—	—	—	—
PCB-1242	—	—	1.40E-02	1.20E+00	—	—
PCB-1248	—	—	1.40E-02	1.40E+00	—	—
PCB-1254	—	—	1.40E-02	6.00E-01	—	—
PCB-1260	—	—	1.40E-02	1.70E+03	—	—
PCB-1262	—	—	—	—	—	—
PCB-1268	—	—	—	—	—	—
Pentachloro-dibenzo[b,e][1,4]dioxin	—	—	—	—	—	—
Pentachlorodibenzofran	—	—	—	—	—	—
Pentachlorophenol	—	—	1.49E+01	1.95E+01	2.00E-03	2.00E+00
Pesticides (Total)	—	—	—	—	1.00E-01	1.00E+02
Phenanthrene	4.19E-02	5.15E-01	—	3.00E+01	1.00E-01	5.15E-01
Phenol	—	—	2.56E+02	3.60E+03	5.00E-02	5.00E+01
Phthalates (total)	—	—	—	—	1.00E-01	1.00E+02
Polychlorinated biphenyl	—	—	1.40E-03	—	—	—
Polychlorinated biphenyl, Dissolved	—	—	—	—	—	—
Polychlorinated biphenyls 31	—	—	—	—	—	—
Polychlorinated biphenyls 99	—	—	—	—	—	—
Polychlorinated biphenyls 132	—	—	—	—	—	—
Polychlorinated biphenyls 153	—	—	—	—	—	—
Polychlorinated biphenyls 170	—	—	—	—	—	—
Polycyclic aromatic hydrocarbons (PAH)	—	—	—	—	—	—
Polycyclic chlorinated hydrocarbons (total)	—	—	—	—	1.00E-01	1.00E+02
Pyrene	5.30E-02	8.75E-01	—	—	1.00E-01	8.75E-01
1,1,2,2-Tetrachloroethane	—	—	2.40E+02	2.10E+03	—	—
2,2'3,4-Tetrachlorobiphenyl	—	—	—	—	—	—
2,3,7,8-Tetrachlorodibenzofuran	—	—	—	—	—	—
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.00E-08	—	1.40E-06	—	—	6.35E-06
1,1,1-Trichloroethane	9.60E-02	—	5.28E+02	2.00E+02	—	—
2,3,3-Trimethylhexane	—	—	—	—	—	—
2,3,4-Trimethylhexane	—	—	—	—	—	—
p-Toluenesulfonamide	—	—	—	—	—	—
Tetrachloro-dibenzo[b,e][1,4]dioxin	—	—	—	—	—	—
Tetrachlorodibenzofuran	—	—	—	—	—	—
Tetrachloroethene	3.20E-02	—	8.40E+01	8.30E+02	—	1.00E+01
Toluene	5.00E-01	—	1.75E+02	1.20E+02	5.00E-02	5.00E+01
Total Organic Nitrogen	—	—	—	—	—	—
Trichloroethene	5.20E-02	—	4.70E+01	4.40E+02	1.00E-03	1.00E+00
Trihalomethanes (Total)	—	—	—	—	—	—
Trimethylsilanol	—	—	—	—	—	—
Vinyl chloride	—	—	—	—	1.00E-02	1.00E+01
Radionuclides	**(pCi/g)**	**(pCi/g)**	**(pCi/L)**	**(pCi/L)**	**(pCi/g)**	**(pCi/g)**
Alpha activity	—	—	—	—	—	—
Americium-241	1.67E+05	—	1.17E+03	—	—	—
Beta activity	—	—	—	—	—	—
Beta/Gamma Activity	—	—	—	—	—	—
Dissolved Alpha	—	—	—	—	—	—
Dissolved Beta	—	—	—	—	—	—
Gross Alpha Total Solids	—	—	—	—	—	—

Table A.11. Ecological No Further Action and Upper Screening Values for Sediment, Surface Water and Soil, PGDP, Paducah, Kentucky (continued)

Analyte	Sediment NFA Value[a]	Sediment Upper Screening Value[b]	Surface Water NFA Value[c]	Surface Water Upper Screening Value[d]	Soil NFA Value[e]	Soil Upper Screening Value[f]
Gross Beta Total Solids	—	—	—	—	—	—
Neptunium-237	2.23E+04	—	1.34E+03	—	—	—
Neptunium-237/Protactinium-233	—	—	—	—	—	—
Cesium-137	9.32E+03	—	7.72E+03	—	—	—
Technetium-99	—	—	1.94E+06	—	—	—
Plutonium-238	9.59E+06	—	1.17E+03	—	—	—
Plutonium-239	—	—	1.25E+03	—	—	—
Plutonium-239/240	1.00E+07	—	1.24E+03	—	2.02E+03	—
Protactinium-234m	1.75E+05	—	—	—	—	—
Radium	2.82E+03	—	—	—	—	—
Strontium-90	5.57E+04	—	6.29E+04	—	—	—
Suspended Alpha	—	—	—	—	—	—
Suspended Beta	—	—	—	—	—	—
Thorium-228	3.31E+03	—	6.01E+01	—	—	—
Thorium-230	1.12E+07	—	4.13E+02	—	—	—
Thorium-232	5.47E+03	—	4.78E+02	—	—	—
Thorium-234	1.75E+05	—	—	—	—	—
Tritium	—	—	—	—	—	—
Uranium	—	—	—	—	—	—
Uranium-234	1.00E+07	—	4.04E+03	—	—	—
Uranium-235	2.96E+04	—	4.37E+03	—	—	—
Uranium-235/236	—	—	—	—	—	—
Uranium-238	1.75E+05	—	4.55E+03	—	—	—

[a] PGDP Sediment No Further Action value (DOE 2001)
[b] PGDP Sediment Upper Screening Value (DOE 2001)
[c] PGDP Surface Water No Further Action value (DOE 2001)
[d] PGDP Surface Water Upper Screening Value (DOE 2001)
[e] PGDP Soil No Further Action value (DOE 2001)
[f] PGDP Soil Upper Screening Value (DOE 2001)
NFA = No further action
PAH = Polycyclic aromatic hydrocarbons
— = no value

Table A.12. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 001 – Sediment: Maximum Site Concentration"	Outfall 001 – Sediment: Frequency of Detection Above NFA	Outfall 001 – Sediment: Frequency of Detection Above USV
		Inorganics				
Aluminum	mg/kg	25500	–	17500	0/6	NA
Antimony	mg/kg	2	–	6	216	NA
Arsenic	mg/kg	5.9	17	33.7	416	316
Barium	mg/kg	–	–	922	NA	NA
Beryllium	mg/kg	–	–	13.7	NA	NA
Cadmium	mg/kg	0.27	3.53	3.4	4/6	016
Calcium	mg/kg	–	–	6060	NA	NA
Chromium	mg/kg	37.3	90	80.8	216	0/6
Cobalt	mg/kg	–	–	50.7	NA	NA
Copper	mg/kg	30	149	123	1/6	0/6
Iron	mg/kg	2000	–	42000	616	NA
Lead	mg/kg	12	91.3	36.5	416	016
Magnesium	mg/kg	–	–	2400	NA	NA
Manganese	mg/kg	614	–	4150	1/6	NA
Mercury	mg/kg	0.16	0.486	0.43	216	016
Molybdenum	mg/kg	–	–	18	NA	NA
Nickel	mg/kg	16	36	73.5	5/6	2/6
Potassium	mg/kg	–	–	1910	NA	NA
Selenium	mg/kg	0.05	–	6.2	6/6	NA
Silver	mg/kg	0.00038	–	3.8	6/6	NA
Sodium	mg/kg	–	–	676	NA	NA
Thallium	mg/kg	–	–	4.5	NA	NA
Tin	mg/kg	–	–	17	NA	NA
Total Organic Carbon (TOC)	mg/kg	–	–	2400	NA	NA
Uranium	mg/kg	–	–	280	NA	NA
Vanadium	mg/kg	0.2	–	80.7	6/6	NA
Zinc	mg/kg	4.7	315	140	616	016
		Organics				
2-Methylnaphthalene	mg/kg	–	–	0.69	NA	NA
4-Methylphenol	mg/kg	–	–	0.69	NA	NA
Acetone	mg/kg	0.091	–	0.25	1/11	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	–	–	0.0013	NA	NA
alpha-Chlordane	mg/kg	–	–	56	NA	NA
Benz(a)anthracene	mg/kg	0.0317	0.385	0.69	5/6	2/6
Benzo(a)pyrene	mg/kg	0.0319	0.782	0.69	5/6	016
Benzo(b)fluoranthene	mg/kg	0.004	–	0.69	616	NA
Benzo(ghi)perylene	mg/kg	–	–	0.69	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	0.018	–	0.58	616	NA
Carbon disulfide	mg/kg	0.00086	–	0.011	8/11	NA
Chlorinated hydrocarbons (total)	mg/kg	–	–	0.0013	NA	NA
Chrysene	mg/kg	0.033	0.862	0.69	516	0/6
delta-BHC	mg/kg	–	–	5.6	NA	NA
Di-n-butyl phthalate	mg/kg	–	–	0.69	NA	NA
Dibenzofuran	mg/kg	–	–	0.69	NA	NA
Endrin ketone	mg/kg	–	–	11	NA	NA
Fluoranthene	mg/kg	0.054	2.23	0.69	4/6	016

Table A.12. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky (continued)

Analyte	Units	PGDP NFA	PGDP USV	Outfall 001 – Sediment: Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
gamma-Chlordane	mg/kg	–	–	56	NA	NA
Methylene chloride	mg/kg	–	–	0.044	NA	NA
Naphthalene	mg/kg	0.01465	0.561	0.69	5/6	2/6
Octathiocane	mg/kg	–	–	0.26	NA	NA
Organochlorinated pesticides (total)	mgkg	–	–	0.0141	NA	NA
PCB-1248	mg/kg	–	–	29	NA	NA
PCB-1254	mg/kg	–	–	110	NA	NA
PCB-1260	mg/kg	–	–	11	NA	NA
Phenanthrene	mg/kg	0.0419	0.515	0.69	4/6	3/6
Phthalates (total)	mg/kg	–	–	0.36	NA	NA
Polychlorinated Biphenyl	mg/kg	0.032	0.277	35.1	20/25	16/25
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1.61	22.8	3.11	10/22	0/22
Polycyclic chlorinated hydrocarbons (total)	mg/kg	–	–	35.1	NA	NA
Pyrene	mg/kg	0.053	0.875	0.69	5/6	0/6
Toluene	mg/kg	0.5	–	0.21	0/11	NA
Total Cyclic Aromatic Hydrocarbons	mgkg	–	–	3.11	NA	NA
Total Pesticides	mg/kg	–	–	0.0141	NA	NA
		Radionuclides				
Alpha activity	pCi/g	–	–	1378.68	NA	NA
Americium-241	pCi/g	167000	–	9.43	0/6	NA
Beta activity	pCi/g	–	–	1600	NA	NA
Cesium-137	pCi/g	9320	–	51	0/5	NA
Neptunium-237	pCi/g	22300	–	63	0/23	NA
Plutonium-239	pCi/g	–	–	240	NA	NA
Plutonium-239/240	pCi/g	10000000	–	41.6	0/3	NA
Technetium-99	pCi/g	–	–	3900	NA	NA
Thorium-230	pCi/g	11200000	–	1300	0/22	NA
Uranium	pCi/g	–	–	473	NA	NA
Uranium-234	pCi/g	10000000	–	150	0/19	NA
Uranium-235	pCi/g	29600	–	12	0/15	NA
Uranium-235/236	pCi/g	–	–	1.35	NA	NA
Uranium-238	pCi/g	175000	–	314.1	0/19	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.13. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky

				Outfall 001 – Surface Water		
Analyte	**Units**	**PGDP NFA**	**PGDP USV**	**Maximum Site Concentration"**	**Frequency of Detection Above NFA**	**Frequency of Detection Above USV**
			Inorganics			
Aluminum	mg/L	0.087	0.75	6.6	16/18	2/18
Antimony	mg/L	0.16	0.18	0.2	11/23	11/23
Arsenic	mg/L	0.05	–	0.2	6/23	NA
Barium	mg/L	0.004	0.11	0.072	12/12	0/12
Beryllium	mg/L	0.00053	0.035	0.01	22/23	0/23
Boron	mg/L	0.75	0.03	0.378	0/12	12/12
Cadmium	mg/L	0.00142	0.00206	0.05	22/29	17/29
Calcium	mg/L	–	–	94.9	NA	NA
Calcium hardness	mg/L	–	–	273	NA	NA
Chromium	mg/L	–	–	0.05	NA	NA
Chromium, hexavalent	mg/L	0.011	0.016	0.01	0/6	0/6
Cobalt	mg/L	0.023	1.5	0.05	5/12	0/12
Copper	mg/L	0.00516	0.00728	0.1	24/29	19/29
Iron	mg/L	1	4	4.69	3/29	1/29
Lead	mg/L	0.00132	0.03378	0.25	25/29	11/29
Magnesium	mg/L	–	–	48.8	NA	NA
Manganese	mg/L	0.12	2.3	0.0934	0/12	0/12
Mercury	mg/L	0.000012	0.0017	0.0002	22/22	0/22
Molybdenum	mg/L	0.37	16	0.02	0/12	0/12
Nickel	mg/L	0.029	0.261	0.1	18/29	0129
Phosphorous	mg/L	–	–	0.32	NA	NA
Potassium	mg/L	–	–	30.6	NA	NA
Selenium	mg/L	*0.005*	*0.02*	0.2	7/23	6/23
Silicon	mg/L	–	–	8.38	NA	NA
Sodium	mg/L	–	–	218	NA	NA
Suspended Solids	mg/L	–	–	131	NA	NA
Thallium	mg/L	0.004	0.11	0.25	21/23	11/23
Uranium	mg/L	0.0026	0.046	0.5	33/38	11/38
Vanadium	mg/L	0.02	0.28	0.05	6/12	0/12
Zinc	mg/L	0.067	0.0665	0.205	18/29	18/29
			Organics			
2-Propanol	mg/L	0.0075	0.13	1	3/3	3/3
Acetone	mg/L	1.5	28	1	0/9	0/9
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.02	7/7	0/7
Diethyl phthalate	mg/L	0.521	1.8	0.022	0/7	0/7
PCB-1248	mg/L	0.000014	0.0014	0.1	35/35	6/35
PCB-1254	mg/L	0.000014	0.0006	0.1	35/35	6/35
PCB-1260	mg/L	0.000014	1.7	0.1	35/35	0/35
Phthalates (total)	mg/L	–	–	0.033	NA	NA
Polychlorinated Biphenyl	mg/L	0.0000014	0.002	0.0004	10/48	0/48
Polycyclic chlorinated hydrocarbons (total)	mg/L			*0.0004*	NA	NA
			Radionuclides			
Alpha activity	pCi/L	–	–	70	NA	NA
Beta activity	pCi/L			106.55	NA	NA
Gross Beta Total Solids	pCi/L	–	–	21.8	NA	NA
Plutonium-238	pCi/L	1170	–	0.64	0/12	NA

Table A.13. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky (continued)

				Outfall 001 – Surface Water		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
Suspended Beta	pCi/L	–	–	34	NA	NA
Technetium-99	pCi/L	1940000	–	96.9	0/45	NA
Thorium-230	pCi/L	413	–	3.96	0/4	NA
Uranium-234	pCi/L	4040	–	4.8	0/12	NA
Uranium-235	pCi/L	4370	–	0.87	0/12	NA
Uranium-238	pCi/L	4550	–	8.7	0/12	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.14. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky

				Outfall 001 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration'	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	5	*50000*	15700	19/19	0/19
Antimony	mg/kg	1.9	3500	98.1	12/19	0/19
Arsenic	mg/kg	1	17	130.36	31/31	7/31
Barium	mg/kg	20	90.9	1140	30/30	20/30
Beryllium	mg/kg	0.19	30.3	1.1	19/19	0/19
Cadmium	mg/kg	0.11	3.53	6.53	22/27	8/27
Calcium	mg/kg	–	–	267000	NA	NA
Chromium	mg/kg	0.4	90	66.62	31/31	0/31
Cobalt	mg/kg	2.5	20000	47.6	18/19	0/19
Copper	mg/kg	0.45	149	50.9	19/19	0/19
Iron	mg/kg	110	200000	54000	19/19	0/19
Lead	mg/kg	20	91.3	51.53	6/31	0/31
Magnesium	mg/kg	–	–	15900	NA	NA
Manganese	mg/kg	25	100000	736	19/19	0/19
Mercury	mg/kg	0.1	0.03	0.9	11/31	22/31
Nickel	mg/kg	11	36	37.58	23/31	1/31
pH	Std Unit	–	–	6.8	NA	NA
Potassium	mg/kg	–	–	1700	NA	NA
Selenium	mg/kg	0.21	1.52	12.5	18/31	5/31
Silver	mg/kg	1	2000	83.3	21/31	0/31
Sodium	mg/kg	–	–	432	NA	NA
Thallium	mg/kg	1	1000	5.34	7/23	0/23
Uranium	mg/kg	5	28.1	6500	57/62	50/62
Vanadium	mg/kg	2	2000	36.1	19/19	0/19
Zinc	mg/kg	8.5	315	203	18/19	0/19
			Organics			
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	mg/kg	–	–	0.000249	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran	mg/kg	–	–	0.000029	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	mg/kg	–	–	0.00000393	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.0000039	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.00000357	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.00000997	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	mg/kg	–	*0.0016*	0.000016	NA	0/3
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.00000712	NA	NA
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	mg/kg	–	–	*0.00000*199	NA	NA
1,2,3,7,8-Pentachlorodibenzofuran	mg/kg	–	0.0016	0.00000117	NA	0/3

Table A.14. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky (continued)

				Outfall 001 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
2,2',3,4',5',6-Hexachloro-1,1'-biphenyl	mg/kg	–	–	1	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.00000245	NA	NA
2,3,4,7,8-Pentachlorodibenzof an	mg/kg	–	6.36284E-05	0.0000035	NA	0/3
2,3,7,8-Tetrachlorodibenzofuran	mg/kg	–	–	0.001	NA	NA
2,5-Hexanedione	mg/kg	–	–	0.2	NA	NA
3,5-Dimethylheptane	mg/kg	–	–	0.65	NA	NA
Acenaphthene	mg/kg	20	1768	1	0130	0130
Acetone	mg/kg	–	–	0.18	NA	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.005	0/1	0/1
Anthracene	mg/kg	0.1	0.845	1.4	30130	1/30
Benz(a)anthracene	mg/kg	–	0.385	3.7	NA	25/30
Benzo(a)pyrene	mg/kg	0.1	0.782	**4**	29/30	3/30
Benzo(b)fluoranthene	mg/kg	–	–	5.8	NA	NA
Benzo(ghi)perylene	mg/kg	–	–	2.1	NA	NA
Benzo(k)fluoranthene	mg/kg	–	–	2.2	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	–	–	1.3	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.01	0/1	0/1
Chrysene	mg/kg	–	0.862	4.4	NA	3130
Di-n-butyl phthalate	mg/kg	200	200000	0.8	0/26	0126
Dioxins, total equivalent	mg/kg	–	–	0.012	NA	NA
Fluoranthene	mg/kg	0.1	2.23	9.1	25/30	2/30
Fluorene	mg/kg	–	0.536	1	NA	9/30
Hexachlorobiphenyl	mg/kg	–	–	1.1	NA	NA
Hexadecanoic acid	mg/kg	–	–	0.3	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	–	–	2.5	NA	NA
Methyl Isobutyl Carbinol	mg/kg	–	–	0.24	NA	NA
Methylene chloride	mg/kg	2	2000	0.11	0112	0112
Naphthalene	mg/kg	0.1	0.561	1.1	30130	10/30
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.01263	NA	NA
Octachlorodibenzof a n	mg/kg	–	–	0.001	NA	NA
PCB-1254	mg/kg	–	–	292	NA	NA
PCB-1260	mg/kg	–	–	370	NA	NA
Pentachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.00106	NA	NA
Pentachlorodibenzofuran	mg/kg	–	–	0.00179	NA	NA
Pentachlorophenol	mg/kg	0.002	2	3.7	26/26	9/26
Phenanthrene	mg/kg	0.1	0.515	8.1	27/30	12/30
Phthalates (total)	mg/kg	0.1	100	0.45	3/6	0/6
Polychlorinated Biphenyl	mg/kg	0.02	0.12	660	68/129	51/129
Polychlorinated biphenyls 153	mg/kg	–	–	1.1	NA	NA
Polychlorinated biphenyls 170	mg/kg	–	–	0.81	NA	NA
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1	10.1	**53**	781113	32/113

Table A.14. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 001, PGDP, Paducah, Kentucky (continued)

				Outfall 001 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
Polycyclic chlorinated hydrocarbons (total)	mg/kg	0.1	100	660	53/81	5/81
Pyrene	mg/kg	0.1	0.875	8.6	27/30	4/30
Total Cyclic Aromatic Hydrocarbons	mg/kg	0.1	100	53	88/89	0189
			Radionuclides			
Alpha activity	pCi/g	–	–	98.68	NA	NA
Americium-241	pCi/g	975	–	**9.4**	0/27	NA
Beta activity	pCi/g	–	–	284.827	NA	NA
Beta/Gamma Activity	pCi/g	–	–	60	NA	NA
Cesium-137	pCi/g	1241	–	50	0/27	NA
Neptunium-237	pCi/g	1684	–	0.6	0/24	NA
Plutonium-239	pCi/g	2035	–	7.9	0/21	NA
Plutonium-239/240	pCi/g	2021	–	10.7	0/2	NA
Technetium-99	pCi/g	6568	–	58	0/36	NA
Thorium-230	pCi/g	3990	–	14	0/23	NA
Uranium	pCi/g	–	–	20	NA	NA
Uranium-234	pCi/g	1990	–	51.9	0/15	NA
Uranium-235	pCi/g	1746	–	7.2	0/18	NA
Uranium-235/236	pCi/g			7.7	NA	NA
Uranium-238	pCi/g	1063	–	314	0/15	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.15. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky

				Outfall 008 – Sediment		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	25500	–	12100	0/6	NA
Arsenic	mg/kg	5.9	17	5.7	016	016
Barium	mg/kg	–	–	274	NA	NA
Beryllium	mg/kg	–	–	3	NA	NA
Cadmium	mg/kg	0.27	3.53	2	5/6	016
Calcium	mg/kg	–	–	8500	NA	NA
Chromium	mg/kg	37.3	90	85.3	1/6	016
Cobalt	mg/kg	–	–	16.4	NA	NA
Copper	mg/kg	30	149	44.3	1/6	016
Cyanide	mg/kg	–	–	0.65	NA	NA
Iron	mg/kg	2000	–	48500	616	NA
Lead	mg/kg	12	91.3	48.5	216	016
Magnesium	mg/kg	–	–	1680	NA	NA
Manganese	mg/kg	614	–	1750	216	NA
Mercury	mg/kg	0.16	0.486	3.28	216	1/6
Nickel	mg/kg	16	36	33.7	2/6	016
Potassium	mg/kg	–	–	898	NA	NA
Selenium	mg/kg	0.05	–	1	616	NA
Sodium	mg/kg	–	–	300	NA	NA
Total Organic Carbon (TOC)	mg/kg	–	–	*570*	NA	NA
Vanadium	mg/kg	0.2	–	97.2	616	NA
Zinc	mg/kg	4.7	315	170	616	016
			Organics			
Acetone	mg/kg	0.09 1	–	0.19	314	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	–	–	0.066	NA	NA
Benzene	mg/kg	0.057	–	0.009	014	NA
Bis(2-ethylhexyl)phthalate	mg/kg	0.018	–	2.8	414	NA
Chlorinated hydrocarbons (total)	mg/kg	–	–	0.066	NA	NA
Di-n-butyl phthalate	mg/kg	–	–	2.8	NA	NA
Fluoranthene	mg/kg	0.054	2.23	2.8	414	1/4
Methylene chloride	mg/kg	–	–	0.066	NA	NA
PCB-1254	mg/kg	–	–	0.4	NA	NA
PCB-1260	mg/kg	–	–	0.7	NA	NA
Phenanthrene	mg/kg	0.04 19	0.5 15	2.8	414	1/4
Phthalates (total)	mg/kg	–	–	0.55	NA	NA
Polychlorinated Biphenyl	mg/kg	0.032	0.277	1.4	418	418
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1.61	22.8	0.45	013	013
Polycyclic chlorinated hydrocarbons (total)	mg/kg	–	–	1.4	NA	NA
Pyrene	mg/kg	0.053	0.875	2.8	414	1/4
Total Cyclic Aromatic Hydrocarbons	mg/kg	–	–	0.46	NA	NA

Table A.15. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky (continued)

Analvte	Units	PGDP NFA	PGDP USV	Outfall 008 – Sediment: Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Radionuclides			
Alpha activity	pCi/g	–	–	350	NA	NA
Beta activity	pCi/g	–	–	1600	NA	NA
Neptunium-237	pCi/g	22300	–	12	0/2	NA
Neptunium-237/ Protactinium-233	pCi/g	–	–	0.66	NA	NA
Plutonium-239	pCi/g	–	–	13	NA	NA
Plutonium-239/240	pCi/g	10000000	–	0.68	0/2	NA
Protactinium-234m	pCi/g	175000	–	27.74	0/2	NA
Technetium-99	pCi/g	–	–	320	NA	NA
Thorium-230	pCi/g	11200000	–	80	0/2	NA
Thorium-234	pCi/g	175000	–	15.63	0/2	NA
Uranium-234	pCi/g	10000000	–	76	0/7	NA
Uranium-235	pCi/g	29600	–	4	0/7	NA
Uranium-238	pCi/g	175000	–	120	0/7	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.16. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky

				Outfall 008 – Surface Water		
Analyte	**Units**	**PGDP NFA**	**PGDP USV**	**Maximum Site Concentration[a]**	**Frequency of Detection Above NFA**	**Frequency of Detection Above USV**
			Inorganics			
Aluminum	mg/L	0.087	0.75	1.71	20/22	1122
Antimony	mg/L	0.16	0.18	0.2	9/22	9/22
Barium	mg/L	0.004	0.11	0.043	22/22	0122
Beryllium	mg/L	0.00053	0.035	0.005	20122	0122
Boron	mg/L	0.75	0.03	2	9/22	21/22
Cadmium	mg/L	0.00142	0.00206	0.02	20122	15/22
Calcium	mg/L	–	–	62.6	NA	NA
Chromium	mg/L	–	–	0.025	NA	NA
Cobalt	mg/L	0.023	1.5	0.05	20122	0122
Copper	mg/L	0.00516	0.00728	0.025	15/22	13/22
Iron	mg/L	1	4	2.37	1/22	0122
Lead	mg/L	0.00132	0.03378	0.2	22/22	9/22
Magnesium	mg/L	–	–	28.8	NA	NA
Manganese	mg/L	0.12	2.3	0.08	0122	0122
Mercury	mg/L	0.000012	0.0017	0.0002	21/21	0121
Molybdenum	mg/L	0.37	16	0.05	0/22	0122
Nickel	mg/L	0.029	0.261	0.05	15/22	0122
Potassium	mg/L	–	–	20.6	NA	NA
Silicon	mg/L	–	–	7.35	NA	NA
Sodium	mg/L	–	–	147	NA	NA
Thallium	mg/L	0.004	0.11	0.2	21/22	9/22
Vanadium	mg/L	0.02	0.28	0.05	19/22	0/22
Zinc	mg/L	0.067	0.0665	0.212	11/22	11/22
			Radionuclides			
Alpha activity	pCi/L	–	–	40	NA	NA
Beta activity	pCi/L	–	–	**80**	NA	NA
Dissolved Beta	pCi/L	–	–	8.1	NA	NA
Gross Alpha Total Solids	pCi/L	–	–	5.1	NA	NA
Gross Beta Total Solids	pCi/L	–	–	17.1	NA	NA
Plutonium-238	pCi/L	1170	–	0.38	0/17	NA
Technetium-99	pCi/L	1940000	–	22.6	0/26	NA
Uranium-234	pCi/L	4040	–	4.49	0119	NA
Uranium-235	pCi/L	4370	–	0.48	0119	NA
Uranium-238	pCi/L	4550	–	5.02	0119	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = **No** Further Action

USV = Upper Screening Value

NA = Not applicable; no **NFA** or USV

– = No NFA or USV

Table A.17. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 008 – Soil Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	5	*50000*	14200	81/81	0/81
Ammonia as Nitrogen	mg/kg	–	–	0.99	NA	NA
Antimony	mg/kg	1.9	3500	99	44/76	0/76
Arsenic	mg/kg	1	17	45.2	92/93	2/93
Barium	mg/kg	20	90.9	280	93/93	40/93
Beryllium	mg/kg	0.19	30.3	15.4	81/81	0/81
Cadmium	mg/kg	0.11	3.53	6.5	81/93	12/93
Calcium	mg/kg	–	–	277000	NA	NA
Chromium	mg/kg	0.4	90	258	93/93	2/93
Cobalt	mg/kg	2.5	20000	48.1	81/81	0/81
Copper	mg/kg	0.45	149	281	81/81	2/81
Cyanide	mg/kg	0.9	900	1.19	16/55	0/55
Iron	mg/kg	110	200000	37000	81/81	0/81
Kjeldahl Nitrogen	mg/kg	–	–	3.2	NA	NA
Lead	mg/kg	20	91.3	323	22/93	3/93
Magnesium	mg/kg	–	–	10800	NA	NA
Manganese	mg/kg	25	100000	2390	80/81	0/81
Mercury	mg/kg	0.1	0.025	7.7	42/93	84/93
Molybdenum	mg/kg	2	2000	5	10/17	0/17
Nickel	mg/kg	11	36	116	45/93	13/93
Potassium	mg/kg	–	–	1530	NA	NA
Selenium	mg/kg	0.21	1.52	25	64/93	3/93
Silicon	mg/kg	–	–	512	NA	NA
Silver	mg/kg	1	2000	42.5	46/93	0/93
Sodium	mg/kg	–	–	815	NA	NA
Sulfate	mg/kg	–	–	972	NA	NA
Thallium	mg/kg	1	1000	25	29/86	0/86
Total Organic Carbon (TOC)	mg/kg	–	–	555	NA	NA
Uranium	mg/kg	5	28.1	11	3/7	0/7
Vanadium	mg/kg	2	2000	57.5	80/81	0/81
Zinc	mg/kg	8.5	315	398	81/81	2/81
			Organics			
1,1,1-Trichloroethane	mg/kg	–	–	0.61	NA	NA
1,1-Dichloroethene	mg/kg	–	–	0.7	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	mg/kg	–	–	0.003	NA	NA
1,2-Benzenedicarboxylic acid	mg/kg	–	–	0.3	NA	NA
1,2-Dichloroethane	mg/kg	0.4	400	0.032	0/53	0/53
1-Methyl-2-propylcyclohexane	mg/kg	–	–	0.16	NA	NA
1-Methylnaphthalene	mg/kg	–	–	0.47	NA	NA
1-Octadecene	mg/kg	–	–	0.7	NA	NA
2,2',3,4-Tetrachlorobiphenyl	mg/kg	–	–	1.3	NA	NA
2,3,4-Trimethylhexane	mg/kg	–	–	0.5	NA	NA
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	–	6.35284E-06	0.0014	NA	7/7
2,4-Dimethylphenol	mg/kg	–	–	15	NA	NA

Table A.17. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky (continued)

				Outfall 008 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
2-Methylnaphthalene	mg/kg	–	–	7.3	NA	NA
3- and 4- Methylphenol	mg/kg	–	–	8.6	NA	NA
4-Methyl-3-penten-2-one	mg/kg	–	–	0.34	NA	NA
Acenaphthene	mg/kg	20	1768	7.14	0/73	0/73
Acenaphthylene	mg/kg	–	–	7.3	NA	NA
Acetone	mg/kg	–	–	0.58	NA	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	0.1	100	1.47	9/40	0/40
Anthracene	mg/kg	0.1	0.845	7.3	71/73	8/73
Benz(a)anthracene	mg/kg	–	0.385	18	NA	48/73
Benzene	mg/kg	0.05	50	0.03	0/54	0/54
Benzo(a)pyrene	mg/kg	0.1	0.782	16	69/73	9/73
Benzo(b)fluoranthene	mg/kg	–	–	17	NA	NA
Benzo(ghi)perylene	mg/kg	–	–	7.14	NA	NA
Benzo(k)fluoranthene	mg/kg	–	–	11	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	–	–	7.3	NA	NA
Carbon disulfide	mg/kg	–	–	0.032	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	0.1	100	1.47	9/40	0/40
Chloroform	mg/kg	0.001	1	0.032	54/54	0/54
Chrysene	mg/kg	–	0.862	19	NA	9/73
Di-n-butyl phthalate	mg/kg	200	200000	9	0/74	0/74
Di-n-octylphthalate	mg/kg	–	–	7.3	NA	NA
Dibenz(a,h)anthracene	mg/kg	–	–	7.3	NA	NA
Dibenzofuran	mg/kg	–	–	7.2	NA	NA
Dioxins, total equivalent	mg/kg	–	–	0.048	NA	NA
Ethylbenzene	mg/kg	0.05	50	0.032	0/48	0/48
Fluoranthene	mg/kg	0.1	2.23	48	70/73	8/73
Fluorene	mg/kg	–	0.536	7.2	NA	21/73
Heptachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.005	NA	NA
Hexadecanoic acid	mg/kg	–	–	0.21	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	–	–	7.136	NA	NA
Methylene chloride	mg/kg	2	2000	0.063	0/48	0/48
Naphthalene	mg/kg	0.1	0.561	7.3	71/73	23/73
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.039	NA	NA
Octachlorodibenzofan	mg/kg	–	–	0.0018	NA	NA
Octadecene	mg/kg	–	–	0.8	NA	NA
p-Toluenesulfonarnide	mg/kg	–	–	0.21	NA	NA
PCB-1242	mg/kg	–	–	38	NA	NA
PCB-1248	mg/kg	–	–	35	NA	NA
PCB-1254	mg/kg	–	–	143	NA	NA
PCB-1260	mg/kg	–	–	11	NA	NA
PCB-1262	mg/kg	–	–	0.94	NA	NA
PCB-1268	mg/kg	–	–	5.6	NA	NA
Phenanthrene	mg/kg	0.1	0.515	34	67/73	24/73
Phenol	mg/kg	0.05	50	23	75/75	0/75

Table A.17. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 008, PGDP, Paducah, Kentucky (continued)

Analyte	Units	PGDP NFA	PGDP USV	Outfall 008 – Soil: Maximum Site Concentration[a]	Outfall 008 – Soil: Frequency of Detection Above NFA	Outfall 008 – Soil: Frequency of Detection Above USV
Phthalates (total)	mg/kg	0.1	100	9	34137	0/37
Polychlorinated Biphenyl	mg/kg	0.02	0.12	286	96/155	791155
Polychlorinated biphenyls 132	mg/kg	–	–	0.93	NA	NA
Polychlorinated biphenyls 31	mg/kg	–	–	0.47	NA	NA
Polychlorinated biphenyls 99	mg/kg	–	–	0.9	NA	NA
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1	10.1	370.91	2011252	1041252
Polycyclic chlorinated hydrocarbons (total)	mg/kg	0.1	100	286	801103	81103
Pyrene	mg/kg	0.1	0.875	34	71/73	13173
Tetrachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.009	NA	NA
Toluene	mg/kg	*0.05*	*50*	0.032	0148	0148
Total Cresols	mg/kg	*0.5*		8.6	515	NA
Total Cyclic Aromatic Hydrocarbons	mg/kg	0.1	100	371	2491257	471257
Trichloroethene	mg/kg	0.001	1	1.2	54/56	1/56
Trimethylsilanol	mg/kg	–	–	0.0071	NA	NA
Vinyl chloride	mg/kg	0.01	10	0.7	45/56	0156
Radionuclides						
Alpha activity	pCi/g	–	–	805	NA	NA
Americium-241	pCi/g	975	–	7.83	0130	NA
Beta activity	pCi/g	–	–	660	NA	NA
Cesium-137	pCi/g	1241	–	1.5	0121	NA
Neptunium-237	pCi/g	1684	–	12.15	0/38	NA
Neptunium-237/Protactinium-233	pCi/g	–	–	0.42	NA	NA
Plutonium-239	pCi/g	2035	–	0.8	0127	NA
Plutonium-239/240	pCi/g	2021	–	26.82	0120	NA
Protactinium-234m	pCi/g	1063	–	19.83	0/9	NA
Technetium-99	pCi/g	6568	–	640	0169	NA
Thorium-228	pCi/g	154	–	1.4	012	NA
Thorium-230	pCi/g	3990	–	187.9	0/36	NA
Thorium-232	pCi/g	1898	–	1.27	0/2	NA
Thorium-234	pCi/g	1063	–	15.29	019	NA
Uranium	pCi/g	–	–	80	NA	NA
Uranium-234	pCi/g	1990	–	31.1	0/59	NA
Uranium-235	pCi/g	1746	–	1.9	0/53	NA
Uranium-238	pCi/g	1063	–	39.5	0/59	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.18. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 010, PGDP, Paducah, Kentucky

				Outfall 010 – Sediment		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration'	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	25500	–	12600	0/8	NA
Arsenic	mg/kg	5.9	17	**11.3**	4/8	018
Barium	mg/kg	–	–	124	NA	NA
Beryllium	mg/kg	–	–	4.6	NA	NA
Cadmium	mg/kg	0.27	3.53	2.73	8/8	0/8
Calcium	mg/kg	–	–	53400	NA	NA
Chromium	mg/kg	37.3	90	74	3/8	0/8
Cobalt	mg/kg	–	–	9.02	NA	NA
Copper	mg/kg	30	149	15.1	018	0/8
Iron	mg/kg	2000	–	41900	818	NA
Lead	mg/kg	12	91.3	22.3	7/8	0/8
Magnesium	mg/kg	–	–	3850	NA	NA
Manganese	mg/kg	614	–	878	1/8	NA
Nickel	mg/kg	16	36	19.7	1/8	0/8
Potassium	mg/kg	–	–	725	NA	NA
Selenium	mg/kg	0.05	–	1	8/8	NA
Silver	mg/kg	0.00038	–	6.5	8/8	NA
Sodium	mg/kg	–	–	300	NA	NA
Total Organic Carbon (TOC)	mg/kg	–	–	4600	NA	NA
Vanadium	mg/kg	0.2	–	75.5	818	NA
Zinc	mg/kg	4.7	315	92.2	8/8	0/8
			Organics			
Methylene chloride	mg/kg	–	–	0.006	NA	NA
PCB-1254	mg/kg	–	–	0.26	NA	NA
PCB-1260	mg/kg	–	–	1.4	NA	NA
Polychlorinated bipheny1	mg/kg	–	–	1.4	NA	NA
Tetrachloroethene	mg/kg	0.032	–	1	1/5	NA
			Radionuclides			
Alpha activity	pCi/g	–	–	10.06	NA	NA
Beta activity	pCi/g	–	–	24	NA	NA
Plutonium-239	pCi/g	–	–	0.003	NA	NA
Plutonium-239/240	pCi/g	10000000	–	0.025	0/7	NA
Protactinium-234m	pCi/g	175000	–	20.9	0/8	NA
Technetium-99	pCi/g	–	–	4.17	NA	NA
Thorium-230	pCi/g	11200000	–	0.24	0/1	NA
Thorium-234	pCi/g	175000	–	13.58	018	NA
Uranium-234	pCi/g	10000000	–	3.032	0/9	NA
Uranium-235	pCi/g	29600	–	0.29	0/9	NA
Uranium-238	pCi/g	175000	–	15.11	0/9	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.19. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 010, PGDP, Paducah, Kentucky

				Outfall 010 – Surface Water		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/L	0.087	0.75	16.5	23/24	1/24
Antimony	mg/L	0.16	0.18	0.2	11/24	11/24
Arsenic	mg/L	0.05	–	0.01	0/24	NA
Barium	mg/L	0.004	0.11	0.183	24/24	2/24
Beryllium	mg/L	0.00053	0.035	0.005	20/24	0/24
Boron	mg/L	0.75	0.03	2	11/24	23/24
Cadmium	mg/L	0.00142	0.002	0.02	23/24	18/24
Calcium	mg/L	–	–	54.5	NA	NA
Chromium	mg/L	–	–	0.0289	NA	NA
Cobalt	mg/L	0.023	1.5	0.05	21/24	0/24
Copper	mg/L	0.00516	0.00728	0.0392	20/24	15/24
Iron	mg/L	1	4	13.7	1/24	1/24
Lead	mg/L	0.00132	0.03378	0.2	24/24	11/24
Magnesium	mg/L	–	–	12.2	NA	NA
Manganese	mg/L	0.12	2.3	0.18	1/24	0/24
Molybdenum	mg/L	0.37	16	0.05	0/24	0/24
Nickel	mg/L	0.029	0.261	0.05	18/24	0/24
Potassium	mg/L	–	–	6.16	NA	NA
Silicon	mg/L	–	–	29.9	NA	NA
Silver	mg/L	0.000012	0.00123	0.025	24/24	23/24
Sodium	mg/L	–	–	69.3	NA	NA
Vanadium	mg/L	0.02	0.28	0.05	20/24	0/24
Zinc	mg/L	0.067	0.0665	0.2	15/24	15/24
			Organics			
Acetone	mg/L	1.5	28	0.01	0/3	0/3
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.02	4/4	0/4
Di-n-butyl phthalate	mg/L	0.0094	0.19	0.02	3/4	0/4
Diethyl phthalate	mg/L	0.521	1.8	0.02	0/4	0/4
Phthalates (total)	mg/L	–	–	0.026	NA	NA
			Radionuclides			
Alpha activity	pCi/L	–	–	20	NA	NA
Beta activity	pCi/L	–	–	70	NA	NA
Dissolved Alpha	pCi/L	–	–	4.3	NA	NA
Dissolved Beta	pCi/L	–	–	9.3	NA	NA
Gross Alpha Total Solids	pCi/L	–	–	1.74	NA	NA
Gross Beta Total Solids	pCi/L	–	–	5.47	NA	NA
Plutonium-238	pCi/L	1170	–	0.88	0/13	NA
Plutonium-239/240	pCi/L	1240	–	0.64	0/15	NA
Protactinium-234m	pCi/L	–	–	2562	NA	NA
Technetium-99	pCi/L	1940000	–	23.4	0/20	NA
Uranium-234	pCi/L	4040	–	1.31	0/20	NA
Uranium-235	pCi/L	4370	–	0.31	0/20	NA
Uranium-238	pCi/L	4550	–	7.4	0/20	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.20. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 010, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 010 – Soil: Maximum Site Concentration"	Outfall 010 – Soil: Frequency of Detection Above NFA	Outfall 010 – Soil: Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	5	50000	12900	23/23	0/23
Antimony	mg/kg	1.9	3500	26.4	18/23	0/23
Arsenic	mg/kg	1	17	19.5	25/25	1/25
Barium	mg/kg	20	90.9	161	25/25	4/25
Beryllium	mg/kg	0.19	30.3	1.6	23/23	0/23
Cadmium	mg/kg	0.11	3.53	5	25/25	2/25
Calcium	mg/kg	–	–	42900	NA	NA
Chromium	mg/kg	0.4	90	90.4	25/25	1/25
Cobalt	mg/kg	2.5	20000	10.3	23/23	0/23
Copper	mg/kg	0.45	149	52.8	23/23	0/23
Iron	mg/kg	110	200000	35000	23/23	0/23
Lead	mg/kg	20	91.3	33.5	2/25	0/25
Lithium	mg/kg	2	2000	8.01	2/2	0/2
Magnesium	mg/kg	–	–	3471	NA	NA
Manganese	mg/kg	25	100000	807	23/23	0/23
Mercury	mg/kg	0.1	0.025	0.2	17/25	25/25
Molybdenum	mg/kg	2	2000	5	11/21	0/21
Nickel	mg/kg	11	36	16.22	7/25	0/25
Potassium	mg/kg	–	–	1490	NA	NA
Silicon	mg/kg	–	–	950	NA	NA
Silver	mg/kg	1	2000	5.2	25/25	0/25
Sodium	mg/kg	–	–	639	NA	NA
Strontium	mg/kg	–	–	34.5	NA	NA
Uranium	mg/kg	5	28.1	9	2/2	0/2
Vanadium	mg/kg	2	2000	58.3	23/23	0/23
Zinc	mg/kg	8.5	315	276	23/23	0/23
			Organics			
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	mg/kg	–	–	0.00045	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran	mg/kg	–	–	0.0000637	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	mg/kg	–	–	0.0000059	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.0000066	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.00000856	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.0000182	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	mg/kg	–	0.0016	0.00000439	NA	0/2
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.00000943	NA	NA
1,2,3,7,8,9-Hexachlorodibenzofan	mg/kg	–	–	0.00000304	NA	NA
1,2,3,7,8-Pentachlorodibenzofuran	mg/kg	–	0.0016	0.0000061	NA	0/2

Table A.20. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 010, PGDP, Paducah, Kentucky (continued)

Analyte	Units	PGDP NFA	PGDP USV	Outfall 010 – Soil Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
2,3,4,6,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.00000304	NA	NA
2,3,4,7,8-Pentachlorodibenzof r a n	mg/kg	–	6.36284E-05	0.0000144	NA	012
2,3,7,8-Tetrachlorodibenzofuran	mglkg	–	–	0.00005	NA	NA
Acenaphthene	mg/kg	20	1768	0.5	0/5	0/5
Acetone	mg/kg	–	–	1.5	NA	NA
Anthracene	mg/kg	0.1	0.845	0.51	5/5	015
Benz(a)anthracene	mg/kg	–	0.385	1.3	NA	3/5
Benzo(a)pyrene	mg/kg	0.1	0.782	2.4	5/5	2/5
Benzo(b)fluoranthene	mg/kg	–	–	5	NA	NA
Benzo(ghi)perylene	mg/kg	–	–	1.18	NA	NA
Benzo(k)fluoranthene	mg/kg	–	–	0.54	NA	NA
Chrysene	mg/kg	–	0.862	1.6	NA	215
Dibenz(a,h)anthracene	mg/kg	–	–	0.5	NA	NA
Dibenzofuran	mg/kg	–	–	0.5	NA	NA
Diethyl phthalate	mg/kg	100	100000	0.5	0/5	0/5
Fluoranthene	mg/kg	0.1	2.23	2.66	5/5	1/5
Fluorene	mg/kg	–	0.536	0.5	0/5	015
Indeno(1,2,3-cd)pyrene	mg/kg	–	–	1.3	NA	NA
Naphthalene	mg/kg	0.1	0.561	0.52	5/5	0/5
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.0253	NA	NA
Octachlorodibenzofran	mg/kg	–	–	0.000175	NA	NA
PCB-1016	mg/kg	–	–	1.87	NA	NA
PCB-1254	mg/kg	–	–	0.545	NA	NA
PCB-1260	mg/kg	–	–	1.183	NA	NA
Phenanthrene	mg/kg	0.1	0.515	1.63	5/5	3/5
Polychlorinated biphenyl	mg/kg	–	–	0.9	NA	NA
Pyrene	mg/kg	0.1	0.875	2.25	5/5	2/5
			Radionuclides			
Alpha activity	pCi/g	–	–	142	NA	NA
Americium-241	pCi/g	975	–	13	0/18	NA
Beta activity	pCi/g	–	–	2730	NA	NA
Cesium-137	pCi/g	1241	–	2.5	0/8	NA
Neptunium-237	pCi/g	1684	–	12.8	0/3	NA
Protactinium-234m	pCi/g	1063	–	460	0/18	NA
Technetium-99	pCi/g	6568	–	2650	0/21	NA
Thorium-234	pCi/g	1063	–	122	0121	NA
Uranium	pCi/g	–	–	69.2	NA	NA
Uranium-234	pCi/g	1990	–	16.4	0/13	NA
Uranium-235	pCi/g	1746	–	9.9	0/18	NA
Uranium-238	pCi/g	1063	–	51.7	0113	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.21. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 011 – Sediment: Maximum Site Concentration"	Outfall 011 – Sediment: Frequency of Detection Above NFA	Outfall 011 – Sediment: Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	25500	–	10800	012	NA
Arsenic	mg/kg	5.9	17	12.5	1/2	012
Barium	mg/kg	–	–	103	NA	NA
Beryllium	mg/kg	–	–	7	NA	NA
Cadmium	mg/kg	0.27	3.53	2	212	012
Calcium	mg/kg	–	–	6080	NA	NA
Chromium	mg/kg	37.3	90	160	212	112
Cobalt	mg/kg	–	–	10.9	NA	NA
Copper	mg/kg	30	149	39.7	112	012
Iron	mg/kg	2000	–	20500	212	NA
Lead	mg/kg	12	91.3	28	112	012
Magnesium	mg/kg	–	–	1730	NA	NA
Manganese	mg/kg	614	–	593	012	NA
Nickel	mg/kg	16	36	24.9	112	012
Potassium	mg/kg	–	–	546	NA	NA
Selenium	mg/kg	0.05	–	0.17	212	NA
Sodium	mg/kg	–	–	118	NA	NA
Total Organic Carbon (TOC)	mg/kg	–	–	2500	NA	NA
Vanadium	mg/kg	0.2	–	42.9	212	NA
Zinc	mg/kg	4.7	315	169	212	012
			Organics			
Acenaphthene	mg/kg	0.089	–	0.52	212	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	–	–	5.343	NA	NA
Anthracene	mg/kg	0.023	0.845	0.52	212	012
Benz(a)anthracene	mg/kg	0.03 17	0.385	1.1	212	1/2
Benzo(a)pyrene	mg/kg	0.03 19	0.782	1.2	2/2	1/2
Benzo(b)fluoranthene	mg/kg	0.004	–	1.4	212	NA
Benzo(ghi)perylene	mg/kg	–	–	0.74	NA	NA
Benzo(k)fluoranthene	mg/kg	0.004	–	1.1	2/2	NA
Carbazole	mg/kg	–	–	0.3	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	–	–	5.343	NA	NA
Chrysene	mg/kg	0.033	0.862	1.3	2/2	112
Dibenzofuran	mg/kg	–	–	0.52	NA	NA
Fluoranthene	mg/kg	0.054	2.23	2.9	212	112
Fluorene	mg/kg	0.0 1	0.536	0.52	212	012
Indeno(1,2,3-cd)pyrene	mg/kg	0.01732	–	0.68	2/2	NA
Methylene chloride	mg/kg	–	–	0.013	NA	NA
Naphthalene	mg/kg	*0.0*1465	0.561	0.52	212	012
PCB-1242	mg/kg	–	–	1	NA	NA
PCB-1248	mg/kg	–	–	14	NA	NA
PCB-1254	mg/kg	–	–	6	NA	NA
PCB-1260	mg/kg	–	–	7.5	NA	NA
Phenanthrene	mg/kg	0.0419	0.5 15	2.3	212	212
Polychlorinated Biphenyl	mg/kg	0.032	0.277	55	52/66	52/66

Table A.21. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky (continued)

				Outfall 011 – Sediment		
Analyte	**Units**	**PGDP NFA**	**PGDP USV**	**Maximum Site Concentration"**	**Frequency of Detection Above NFA**	**Frequency of Detection Above USV**
Polycyclic aromatic hydrocarbons **(PAH)**	mg/kg	1.61	22.8	16.18	21/22	0122
Polycyclic chlorinated hydrocarbons (total)	mg/kg	–	–	55	**NA**	**NA**
Pyrene	mg/kg	0.053	0.875	2.3	212	1/2
Total Cyclic Aromatic Hydrocarbons	mg/kg	–	–	16.18	**NA**	**NA**
Trichloroethene	mg/kg	0.052	–	5.34	1/6	**NA**
			Radionuclides			
Alpha activity	pCi/g	–	–	330	**NA**	**NA**
Beta activity	pCi/g	–	–	515	**NA**	**NA**
Cesium-137	pCi/g	9320	–	0.16	012	**NA**
Plutonium 23/240	pCi/g	10000000	–	0.011	012	**NA**
Technetium-99	pCi/g	–	–	2	**NA**	**NA**
Thorium-230	pCi/g	11200000	–	0.51	014	**NA**
Uranium	pCi/g	–	–	109	**NA**	**NA**
Uranium-234	pCi/g	10000000	–	7.9	0/2	**NA**
Uranium-235	pCi/g	29600	–	0.6	0/2	**NA**
Uranium-238	pCi/g	175000	–	52	012	**NA**

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or **USV**

– = No NFA or **USV**

Table A.22. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky

				Outfall 011 – Surface Water		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/L	0.087	0.75	4.8	156/157	21/157
Barium	mg/L	0.004	0.11	0.12	13/13	1/13
Beryllium	mg/L	0.00053	0.035	0.01	7/13	0/13
Boron	mg/L	0.75	0.03	0.277	0/6	3/6
Cadmium	mg/L	0.00142	0.00206	0.02	52/100	51/100
Calcium	mg/L	–	–	**45**	NA	NA
Chemical Oxygen Demand (COD)	mg/L	–	–	25	NA	NA
Chloride	mg/L	600	1200	34.8	014	014
Chlorine, Total Residual	mg/L	–	–	**0.25**	NA	NA
Chromium	mg/L	–	–	0.156	NA	NA
Copper	mg/L	0.005	0.007	0.05	158/162	158/162
Dissolved Solids	mg/L	–	–	160	NA	NA
Fluoride	mg/L	–	–	0.63	NA	NA
Hardness - Total as CaCO3	mg/L CaCO3	–	–	250	NA	NA
Iron	mg/L	1	4	8.4	**13/220**	**2/220**
Lead	mg/L	0.0013	0.034	0.2	88/100	43/100
Magnesium	mg/L	–	–	17	NA	NA
Manganese	mg/L	0.12	2.3	3.5	2/13	1/13
Molybdenum	mg/L	0.37	16	0.05	*018*	*018*
Nickel	mg/L	0.029	0.261	0.19	158/161	0/161
Nitrate as Nitrogen	mg/L	–	–	0.6	NA	NA
Nitrate/Nitrite	mg/L	–	–	1.2	NA	NA
Oil and Grease	mg/L	–	–	**8.8**	NA	NA
Phosphorous	mg/L	–	–	0.84	NA	NA
Potassium	mg/L	–	–	10.5	NA	NA
Silicon	mg/L	–	–	3.2	NA	NA
Sodium	mg/L	–	–	31.8	NA	NA
Strontium	mg/L	1.5	15	0.28	0/3	0/3
Sulfate	mg/L	–	–	75	NA	NA
Sulfide	mg/L	0.002	–	2	3/3	NA
Suspended Solids	mg/L	–	–	125	NA	NA
Total Organic Carbon (TOC)	mg/L	–	–	6	NA	NA
Total Phosphate as Phosphorus	mg/L	–	–	0.34	NA	NA
Uranium	mg/L	0.0026	0.046	4	440/447	164/447
Vanadium	mg/L	0.02	0.28	0.05	1/6	016
Zinc	mg/L	0.067	0.0665	0.39	31/359	31/359
1,2-Dichloroethene	mg/L	0.59	1.1	0.022	014	0/4
1,3,5-Cycloheptatriene	mg/L	–	–	0.018	NA	NA
2,3,3-Trimethylhexane	mg/L	–	–	0.011	NA	**NA**
Aliphatic chlorinated hydrocarbons (total)	mg/L	–	–	0.64	**NA**	NA
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	*0.027*	0.025	5/5	0/5
Bromodichloromethane	mg/L	–	–	0.05	NA	NA

Table A.22. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky (continued)

Analyte	Units	PGDP NFA	PGDP USV	Outfall 011 – Surface Water: Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Organics			
Chlorinated hydrocarbons (total)	mg/L	–	–	0.64	NA	NA
Chloroform	mg/L	0.289	0.49	0.05	0124	0/24
cis-1,2-Dichloroethene	mg/L	–	–	0.42	NA	NA
Dichlorodifluoromethane	mg/L	–	–	0.01	NA	NA
PCB-1242	mg/L	0.000014	0.0012	0.001	9/9	0/9
PCB-1248	mg/L	0.000014	0.0014	0.001	7/7	0/7
PCB-1260	mg/L	0.000014	1.7	0.001	26/26	0/26
Phenol	mg/L	0.256	3.6	0.025	019	0/9
Phthalates (total)	mg/L	–	–	0.002	NA	NA
Polychlorinated Biphenyl	mg/L	0.0000014	0.002	0.0026	541329	2/329
Polychlorinated biphenyl, Dissolved	mg/L	–	–	0.0002	NA	NA
Polycyclic chlorinated hydrocarbons (total)	mg/L	–	–	0.002	NA	NA
Total Organic Nitrogen	mg/L	–	–	1	NA	NA
Total Trihalomethanes	mg/L	–	–	0.014	NA	NA
Trichloroethene	mg/L	0.047	0.44	0.22	8/175	0/175
			Radionuclides			
Alpha activity	pCi/L	–	–	237	NA	NA
Beta activity	pCi/L	–	–	132	NA	NA
Dissolved Alpha	pCi/L	–	–	1325	NA	NA
Dissolved Beta	pCi/L	–	–	782	NA	NA
Gross Alpha Total Solids	pCi/L	–	–	79	NA	NA
Gross Beta Total Solids	pCi/L	–	–	42	NA	NA
Neptunium-237	pCi/L	1340	–	3	0/34	NA
Plutonium-238	pCi/L	1170	–	0.46	0/4	NA
Plutonium-239	pCi/L	1250	–	3	0134	NA
Radium	pCi/L	–	–	1.9	NA	NA
Strontium-90	pCi/L	62900	–	-13	0/1	NA
Suspended Alpha	pCi/L	–	–	17.7	NA	NA
Suspended Beta	pCi/L	–	–	113	NA	NA
Technetium-99	pCi/L	1940000	–	224	01373	NA
Thorium-230	pCi/L	413	–	0.8	0/24	NA
Tritium	pCi/L	3450000000	–	640	0/1	NA
Uranium-234	pCi/L	4040	–	36	0/5	NA
Uranium-235	pCi/L	4370	–	8	0/5	NA
Uranium-238	pCi/L	4550	–	324	0/5	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.23. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 011 – Soil: Maximum Site Concentration'	Outfall 011 – Soil: Frequency of Detection Above NFA	Outfall 011 – Soil: Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	5	50000	15400	16/16	0/16
Arsenic	mg/kg	1	17	7	16/16	0/16
Barium	mg/kg	20	90.9	148	13/16	1/16
Beryllium	mg/kg	0.19	30.3	1.6	16/16	0/16
Cadmium	mg/kg	0.11	3.53	2	16/16	0/16
Calcium	mg/kg	–	–	335000	NA	NA
Chromium	mg/kg	0.4	90	371	16/16	3/16
Cobalt	mg/kg	2.5	20000	9.7	11/16	0/16
Copper	mg/kg	0.45	149	158	16/16	1/16
Iron	mg/kg	110	200000	24300	16/16	0/16
Lead	mg/kg	20	91.3	70.5	4/16	0/16
Lithium	mg/kg	2	2000	9	14/15	0/15
Magnesium	mg/kg	–	–	16000	NA	NA
Manganese	mg/kg	25	100000	594	16/16	0/16
Mercury	mg/kg	0.1	0.025	0.43	15/16	15/16
Nickel	mg/kg	11	36	382	7/16	3/16
Potassium	mg/kg	–	–	1400	NA	NA
Selenium	mg/kg	0.21	1.52	5	16/16	3/16
Sodium	mg/kg	–	–	421	NA	NA
Strontium	mg/kg	–	–	475	NA	NA
Thallium	mg/kg	1	1000	15	15/16	0/16
Uranium	mg/kg	5	28.1	1030	12/12	12/12
Vanadium	mg/kg	2	2000	65	16/16	0/16
Zinc	mg/kg	8.5	315	272	16/16	0/16
			Organics			
1,1,1-Trichloroethane	mg/kg	–	–	1	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	mg/kg	–	–	0.000711	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran	mg/kg	–	–	*0.000145*	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	mg/kg	–	–	0.000021	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	*0.00001*	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.000045	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.000394	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	mg/kg	–	*0.0016*	0.000022	NA	0/5
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	mg/kg	–	–	0.0001	NA	NA
1,2,3,7,8,9-Hexachlorodibenzofuran	mg/kg	–	–	0.000002	NA	NA
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	mg/kg	–	–	*0.000005*	NA	NA

Table A.23. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky (continued)

				Outfall 011 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration'	Frequency of Detection Above NFA	Frequency of Detection Above USV
1,2,3,7,8-Pentachlorodibenzofuran	mg/kg	–	0.0016	0.000007	NA	0/5
2,3,4,6,7,8-Hexachlorodibenzofuran	mg/kg	–	–	0.00003	NA	NA
2,3,4,7,8-Pentachlorodibenzofuran	mg/kg	–	6.36284E-05	0.00002	NA	0/5
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	–	6.35284E-06	0.002	NA	6/11
2,3,7,8-Tetrachlorodibenzofuran	mg/kg	–	–	0.00062	NA	NA
2-Methylnaphthalene	mg/kg	–	–	3.7	NA	NA
Acenaphthene	mg/kg	20	1768	12	0/16	0/16
Acenaphthylene	mg/kg	–	–	3.7	NA	NA
Acetone	mg/kg	–	–	14	NA	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.14	2/23	0/23
Anthracene	mg/kg	0.1	0.845	45	16/16	11/16
Benz(a)anthracene	mg/kg	–	0.385	90	NA	16/16
Benzo(a)pyrene	mg/kg	0.1	0.782	113	16/16	12/16
Benzo(b)fluoranthene	mg/kg	–	–	121	NA	NA
Benzo(ghi)perylene	mg/kg	–	–	84	NA	NA
Benzo(k)fluoranthene	mg/kg	–	–	93	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	–	–	3.7	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.14	2/23	0/23
Chrysene	mg/kg	–	0.862	86	NA	11/16
Dibenz(a,h)anthracene	mg/kg	–	–	71	NA	NA
Dibenzofuran	mg/kg	–	–	4.6	NA	NA
Dioxins, total equivalent	mg/kg	–	–	0.07	NA	NA
Fluoranthene	mg/kg	0.1	2.23	71	16/16	11/16
Fluorene	mg/kg	–	0.536	16	NA	11/16
Hexachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.003	NA	NA
Hexachlorodibenzofuran	mg/kg	–	–	0.005	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	–	–	94	NA	NA
Naphthalene	mg/kg	0.1	0.561	4.75	16/16	8/16
Octachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.016	NA	NA
Octachlorodibenzofuran	mg/kg	–	–	0.001	NA	NA
PCB-1242	mg/kg	–	–	192	NA	NA
PCB-1248	mg/kg	–	–	1076	NA	NA
PCB-1254	mg/kg	–	–	192	NA	NA
PCB-1260	mg/kg	–	–	475	NA	NA
Pentachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.025	NA	NA
Pentachlorodibenzofuran	mg/kg	–	–	0.035	NA	NA
Phenanthrene	mg/kg	0.1	0.515	72	16/16	11/16
Phthalates (total)	mg/kg	0.1	100	0.54	1/1	0/1

Table A.23. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 011, PGDP, Paducah, Kentucky (continued)

				Outfall 011 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
Polychlorinated Biphenyl	mg/kg	0.02	0.12	1076	76/102	69/102
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1	10.1	1067.5	183/207	139/207
Polycyclic chlorinated hydrocarbons (total)	mg/kg	0.1	100	1076.4	74/77	8/77
Pyrene	mg/kg	0.1	0.875	108	16/16	11/16
Tetrachloro-dibenzo[b,e][1,4]dioxin	mg/kg	–	–	0.037	NA	NA
Tetrachlorodibenzofuran	mg/kg	–	–	0.021	NA	NA
Tetrachloroethene	mg/kg	0.01	10	1	7/77	0/77
Total Cyclic Aromatic Hydrocarbons	mg/kg	0.1	100	1067.5	149/149	100/149
Trichloroethene	mg/kg	0.001	1	1	82/82	0/82
			Radionuclides			
Alpha activity	pCi/g	–	–	9500	NA	NA
Beta activity	pCi/g	–	–	17400	NA	NA
Plutonium-239/240	pCi/g	2021	–	0.3	0/9	NA
Protactinium-234m	pCi/g	1063	–	5000	2/15	NA
Technetium-99	pCi/g	6568	–	105	0/21	NA
Thorium-234	pCi/g	1063	–	2890	3/24	NA
Uranium	pCi/g	–	–	3160	NA	NA

Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.24. Summary of sediment concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 015, PGDP, Paducah, Kentucky

Analyte	Units	PGDP NFA	PGDP USV	Outfall 015 – Sediment: Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	25500	–	13100	012	NA
Arsenic	mg/kg	5.9	17	9.7	212	0/2
Barium	mg/kg	–	–	192	NA	NA
Beryllium	mg/kg	–	–	7	NA	NA
Cadmium	mg/kg	0.27	3.53	2	212	0/2
Calcium	mg/kg	–	–	2890	NA	NA
Chromium	mg/kg	37.3	90	22.7	0/2	0/2
Cobalt	mg/kg	–	–	62	NA	NA
Copper	mg/kg	30	149	18.8	012	0/2
Iron	mg/kg	2000	–	22200	212	NA
Lead	mg/kg	12	91.3	18	212	0/2
Magnesium	mg/kg	–	–	1820	NA	NA
Manganese	mg/kg	614	–	1500	1/2	NA
Nickel	mg/kg	16	36	33	2/2	0/2
Potassium	mg/kg	–	–	679	NA	NA
Selenium	mg/kg	0.05	–	0.21	2/2	NA
Silver	mg/kg	0.00038	–	3	212	NA
Sodium	mg/kg	–	–	105	NA	NA
Thallium	mg/kg	–	–	0.34	NA	NA
Total Organic Carbon (TOC)	mg/kg	–	–	2000	NA	NA
Vanadium	mg/kg	0.2	–	37.8	212	NA
Zinc	mg/kg	4.7	315	59	212	012
			Organics			
2-Propanol	mg/kg	–	–	1.3	NA	NA
Acetone	mg/kg	0.091	–	25	1/2	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	–	–	0.007	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	–	–	0.007	NA	NA
Methylene chloride	mg/kg	–	–	0.007	NA	NA
PCB-1260	mg/kg	–	–	0.4	NA	NA
Polychlorinated Biphenyl	mg/kg	0.032	0.277	0.8	216	216
Polycyclic chlorinated hydrocarbons (total)	mg/kg	–	–	0.8	NA	NA
			Radionuclides			
Alpha activity	pCi/g	–	–	200	NA	NA
Americium-241	pCi/g	167000	–	2	0/1	NA
Beta activity	pCi/g	–	–	223	NA	NA
Cesium-137	pCi/g	9320	–	52	0/1	NA
Plutonium-239	pCi/g	–	–	0.23	NA	NA
Plutonium-239/240	pCi/g	10000000	–	18	0/1	NA
Technetium-99	pCi/g	–	–	17.9	NA	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.25. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 015, PGDP, Paducah, Kentucky

				Outfall 015 – Surface Water		
Analvte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration"	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/L	0.087	0.75	34	1241124	94/124
Antimony	mg/L	0.16	0.18	0.2	8/18	8/18
Arsenic	mg/L	0.05	–	0.2	4/19	NA
Barium	mg/L	0.004	0.11	0.162	11111	2/11
Beryllium	mg/L	0.00053	0.035	0.01	15/19	0/19
Biochemical Oxygen Demand (BOD)	mg/L	–	–	6	NA	NA
Boron	mg/L	0.75	0.03	0.311	0/8	8/8
Cadmium	mg/L	0.00142	0.00206	0.05	4/78	4/78
Calcium	mg/L	–	–	84	NA	NA
Chemical Oxygen Demand (COD)	mg/L	–	–	40	NA	NA
Chloride	mg/L	600	1200	95	0/8	0/8
Chromium	mg/L	–	–	0.05	NA	NA
Cobalt	mg/L	0.023	1.5	0.05	5/11	0/11
Copper	mg/L	0.00516	0.00728	0.1	131/133	1271133
Fluoride	mg/L	–	–	2.7	NA	NA
Hardness - Total as CaCO3	mg/L	–	–	436	NA	NA
Hardness - Total as CaCO3	mg/L CaCO3	–	–	350	NA	NA
Iron	mg/L	1	4	23	79/133	201133
Lead	mg/L	0.0013	0.034	0.25	72/77	31/77
Magnesium	mg/L	–	–	43	NA	NA
Manganese	mg/L	0.12	2.3	0.2	211 1	0/11
Molybdenum	mg/L	0.37	16	0.5	0/9	0/9
Nickel	mg/L	0.029	0.261	0.26	133/133	0/133
Nitrate/Nitrite	mg/L	–	–	0.27	NA	NA
Oil and Grease	mg/L	–	–	9	NA	NA
Phosphorous	mg/L	–	–	0.46	NA	NA
Potassium	mg/L	–	–	25	NA	NA
Silicon	mg/L	–	–	30	NA	NA
Sodium	mg/L	–	–	191	NA	NA
Strontium	mg/L	1.5	15	0.63	0/1	0/1
Sulfate	mg/L	–	–	560	NA	NA
Sulfide	mg/L	0.002	–	2	3/3	NA
Suspended Solids	mg/L	–	–	850	NA	NA
Thallium	mg/L	0.004	0.11	0.25	17/18	8/18
Titanium	mg/L	–	–	0.05	NA	NA
Total Organic Carbon (TOC)	mg/L	–	–	14	NA	NA
Uranium	mg/L	0.0026	0.046	1	95/95	72/95
Vanadium	mg/L	0.02	0.28	0.05	0/7	017
Zinc	mg/L	0.067	0.0665	0.539	1/77	1/77
			Organics			
1,1,2,2-Tetrachloroethane	mg/L	0.24	2.1	0.01	015	0/5
3-Penten-2-One	mg/L	–	–	0.004	NA	NA
Aldrin	mg/L	0.0003	0.003	0.000054	0/2	0/2

Table A.25. Summary of surface water concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 015, PGDP, Paducah, Kentucky (continued)

				Outfall 015 – Surface Water		
Analvte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration'	Frequency of Detection Above NFA	Frequency of Detection Above USV
Aliphatic chlorinated hydrocarbons (total)	mg/L	–	–	0.004	NA	NA
Bis(2-ethylhexyl)phthalate	mg/L	0.0003	0.027	0.025	3/3	0/3
Chlorinated hydrocarbons (total)	mg/L	–	–	0.004	NA	NA
Organochlorinated pesticides (total)	mg/L	–	–	0.00001	NA	NA
Phthalates (total)	mg/L	–	–	0.003	NA	NA
Polychlorinated Biphenyl	mg/L	0.0000014	0.002	0.0001	0/114	0/114
Polycyclic chlorinated hydrocarbons (total)	mg/L	–	–	0.0001	NA	NA
Total Organic Nitrogen	mg/L	–	–	1.5	NA	NA
Total Pesticides	mg/L	–	–	0.00001	NA	NA
Trichloroethene	mg/L	0.047	0.44	0.01	0/61	0/61
			Radionuclides			
Alpha activity	pCi/L	–	–	54	NA	NA
Beta activity	pCi/L	–	–	400	NA	NA
Dissolved Alpha	pCi/L	–	–	241	NA	NA
Dissolved Beta	pCi/L	–	–	221	NA	NA
Gross Alpha Total Solids	pCi/L	–	–	55.34	NA	NA
Gross Beta Total Solids	pCi/L	–	–	77.82	NA	NA
Neptunium-237	pCi/L	1340	–	3	0/31	NA
Plutonium-239	pCi/L	1250	–	3	0/30	NA
Plutonium-239/240	pCi/L	1240	–	0.25	0/6	NA
Radium	pCi/L	–	–	2	NA	NA
Suspended Alpha	pCi/L	–	–	13.5	NA	NA
Suspended Beta	pCi/L	–	–	140	NA	NA
Technetium-99	pCi/L	1940000	–	113	0/72	NA
Thorium-230	pCi/L	413	–	3.6	0/21	NA
Uranium-234	pCi/L	4040	–	32	0/11	NA
Uranium-235	pCi/L	4370	–	2.08	0/10	NA
Uranium-238	pCi/L	4550	–	140	0/10	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

Table A.26. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 015, PGDP, Paducah, Kentucky

				Outfall 015 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
			Inorganics			
Aluminum	mg/kg	5	50000	17700	717	017
Antimony	mg/kg	1.9	3500	4	1/7	0/7
Arsenic	mg/kg	1	17	46	717	217
Barium	mg/kg	20	90.9	198	717	717
Beryllium	mg/kg	0.19	30.3	21	717	017
Cadmium	mg/kg	0.11	3.53	3.6	5/7	217
Calcium	mg/kg	–	–	39700	NA	NA
Chromium	mg/kg	0.4	90	36.8	717	017
Cobalt	mg/kg	2.5	20000	18.5	717	0/7
Copper	mg/kg	0.45	149	59	7/7	017
Iron	mg/kg	110	200000	24600	7/7	0/7
Lead	mg/kg	20	91.3	40	2/7	0/7
Magnesium	mg/kg	–	–	3120	NA	NA
Manganese	mg/kg	25	100000	670	717	0/7
Mercury	mg/kg	0.1	0.025	0.176	217	717
Nickel	mg/kg	11	36	46.3	717	217
Potassium	mg/kg	–	–	2080	NA	NA
Selenium	mg/kg	0.21	1.52	2.9	6/7	217
Silver	mg/kg	1	2000	2.5	4/7	0/7
Sodium	mg/kg	–	–	620	NA	NA
Thallium	mg/kg	1	1000	1	3/7	0/7
Uranium	mg/kg	5	28.1	14	6/17	0117
Vanadium	mg/kg	2	2000	70	7/7	017
Zinc	mg/kg	8.5	315	101	7/7	0/7
			Organics			
2-Methylnaphthalene	mg/kg	–	–	0.702	NA	NA
4-Methyl-3-penten-2-one	mg/kg	–	–	0.18	NA	NA
Aliphatic chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.01	0/2	0/2
Benz(a)anthracene	mg/kg	–	0.385	0.7	NA	7/10
Benzo(a)pyrene	mg/kg	0.1	0.782	0.7	9/10	0110
Benzo(b)fluoranthene	mg/kg	–	–	0.7	NA	NA
Benzo(ghi)perylene	mg/kg	–	–	0.9	NA	NA
Benzo(k)fluoranthene	mg/kg	–	–	0.7	NA	NA
Chlorinated hydrocarbons (total)	mg/kg	0.1	100	0.007	0/2	0/2
Chloroform	mg/kg	0.001	1	0.007	4/4	0/4
Chrysene	mg/kg	–	0.862	0.702	NA	0/10
Dibenz(a,h)anthracene	mg/kg	–	–	0.93	NA	NA
Fluoranthene	mg/kg	0.1	2.23	0.88	10/10	0/10
Indeno(1,2,3-cd)pyrene	mg/kg	–	–	0.93	NA	NA
Naphthalene	mg/kg	0.1	0.561	4.7	10/10	3/10
PCB-1260	mg/kg	–	–	0.22	NA	NA
Phenanthrene	mg/kg	0.1	0.515	3.8	10/10	2/10
Polychlorinated Biphenyl	mg/kg	0.02	0.12	7	13/102	11/102
Polycyclic aromatic hydrocarbons (PAH)	mg/kg	1	10.1	20	26/40	20/40

Table A.26. Summary of soil concentrations and exceedance of Ecological No Further Action and Upper Screening Values for Outfall 015, PGDP, Paducah, Kentucky (continued)

				Outfall 015 – Soil		
Analyte	Units	PGDP NFA	PGDP USV	Maximum Site Concentration[a]	Frequency of Detection Above NFA	Frequency of Detection Above USV
Polycyclic chlorinated hydrocarbons (total)	mg/kg	0.1	100	7	11/13	0/13
Pyrene	mg/kg	0.1	0.875	0.84	10/10	0/10
Total Cyclic Aromatic Hydrocarbons	mg/kg	0.1	100	15.7	26/26	0/26
			Radionuclides			
Alpha activity	pCi/g	–	–	804	NA	NA
Americium-241	pCi/g	975	–	7.8	0/3	NA
Beta activity	pCi/g	–	–	300	NA	NA
Neptunium-237	pCi/g	1684	–	12	0/6	NA
Plutonium-239	pCi/g	2035	–	2.5	0/4	NA
Plutonium-239/240	pCi/g	2021	–	26	0/2	NA
Technetium-99	pCi/g	6568	–	24	0/6	NA
Thorium-230	pCi/g	3990	–	187	0/6	NA
Uranium	pCi/g	–	–	11	NA	NA
Uranium-234	pCi/g	1990	–	7.9	0/6	NA
Uranium-238	pCi/g	1063	–	14	0/6	NA

[a] Larger of maximum detected concentration and the maximum reported detection limit for samples reported as non-detect, when detected in one or more sample.

NFA = No Further Action

USV = Upper Screening Value

NA = Not applicable; no NFA or USV

– = No NFA or USV

APPENDIX B

COST ESTIMATE AND CONCEPTUAL BASIN DESIGN

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PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 2 - LOCALIZED CONTROLS AND INTEGRATED CONTROLS (OUTFALLS 010,015, AND THE BALANCE OF OUTFALL 001)

Cost Summary

Capital	$69,842
O&M (30 years)	$317,936
Total	$387,778
Escalated Total Cost'	$527,795

[1] **2% per year beginning in 2003**

Cost Estimate Assumptions

Costs for the Localized Controls are not included in this cost estimate.

Rock check dams will be medium size riprap (10-200 lb pieces).

Rock will be dumped and then placed using front end loader.

A geotextile fabric will be applied to maximize check dam effectiveness.

A total of 15 check dams (5 per outfall) will be constructed.

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 2 - LOCALIZED CONTROLS AND INTEGRATED CONTROLS (OUTFALLS010, 015, AND THE BALANCE OFOUTFALL 001)

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Project Plans	160	hr	S0	S0 00	s33 79	50.00	S0	S0	$5,406	S0	55,406
1.2 Project Schedulingand Procurement	200	hr	S0	S0 00	s33 79	so.OO	S0	S0	56.758	S0	56.758
2 MOBILIZATION/DEMOBILIZATION											
2.1 Equipment Mob/Demob (Exc . Loader, & Dozer)	5	ea	S0	S0 00	s200.00	$250.00	S0	S0	$1.000	51.250	S2.250
2.2 Mobilize/Demobilize Personnel (3-persons)	5	ea		5375.00	s300.00		S0	$1,875	$1.500	S0	s3.375
2.3 Portable Toilet	0.5	mo	574	S0 00	S0 00	soOO	537	S0	S0	S0	S37
3 CONSTRUCTION											
3.1 Rock Cover. Riprap. Medium (10 lo 200 lb Pieces)	I500	cy	S0	$15 88	S3 13	$2.21	S0	523.820	54.695	53.315	$31.830
3.2 105 Mil Geotextile. Nonwoven	3750	sy	S0	S0 78	S0 47	50.03	S0	S2.925	$1,763	5113	W.800
Subtotal Direct Capital Costs including Sobcontract							S37	$28.620	$21,122	54.678	554.456
Local Area Adjustment								89%	89%	89%	
							537	s15.529	518.841	$4,172	$48,579
Burden @ 30% of Labor Costs									$5,652		55.652
Total Direct Cost									$24.493	$4,172	554.131
Indirects @ 26% of Total Direct Cost									S6.368	$1,085	$7,453
Total Indirect & Direct Costs											S61.684
Sales Tax @ 6% of Total Indirect & Direct Costs											S1.532
Engineering (Design) @ 6% of Total Indirect & Direct Costs											$3,701
Total Cost											S66.917
Overhead @ 34.87% PCDP Personnel											52.357
Overhead on Indirect Costs @ 7.62%											$568
Total											S69.842

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 2 - LOCALIZED CONTROLS AND INTEGRATED CONTROLS (OUTFALLS 010.015, AND THE BALANCE OF OUTFALL 001)

O&M Cost per month = S10.958

		Capital	O&M	Total Yearly coot	Total Unescalated cost	Escalated Total Net Present Wortb @ 2%/yr.	Escalated Net Present Worth @ 2%/yr. - O&M	Escalated Net Present Wortb @ 2%/yr. - Capital	Escalated Total Net Present Worth @ 2%/yr.
1	2002	$69,842	S10.958	$80,800	$80,800	$80,800	$10,958	S69.842	$80,800
2	2003		$10.958	$10,958	S91.758	S93.858	S22.591	$71,267	S93.858
3	2004		$10,958	$10,958	$102.716	$105.501	$34,234	S71,267	$105,501
4	2005		$10,958	S10.958	$113,674	$117,381	S46.114	$71,267	S117.381
5	2006		$10,958	$10.958	$124,632	$129,504	$58,237	$71,267	$129,504
6	2007		S10.958	$10,958	S135.590	S141,874	570.607	$71,267	$141,874
7	2008		S10.958	$10,958	$146,548	$154.497	S83.230	S71.267	$154.497
8	2009		$10,958	S10.958	S157.506	$167,377	S96.110	S71,267	$167,377
9	2010		S10,958	$10,958	$168.464	S180.520	$109,253	$71,267	$180,520
10	2011		S10.958	510,958	5179.422	$193.931	S122.664	$71,267	$193,931
11	2012		S10.958	$10.958	$190,380	$207,616	$136,349	S71,267	S207.616
12	2013		$10.958	$10,958	$201,338	$221.581	$150,314	571.267	$221.581
13	2014		S10.958	510,958	$212,296	$235,830	$164,563	$71,267	S235.830
14	2015		S10.958	S10.958	$223,254	$250,370	$179,103	S71,267	S250.370
15	2016		$10,958	$10,958	$234,212	S265.207	$193,940	S71,267	$265,207
16	2017		$10,958	$10,958	$245,170	$280,346	$209,079	$71,267	$280,346
17	2018		$10,958	S10.958	$256,128	$295,795	S224.528	S71,267	$295,795
18	2019		$10,958	S10.958	$267,086	$311,559	5240.292	$71.267	$311,559
19	2020		$10,958	S10.958	$278,044	s327.644	S256.377	$71,267	$327,644
20	2021		$10,958	S10.958	S289.002	5344.058	5272.791	571.267	$344,058
21	2022		$10,958	$10,958	5299.960	$360,807	5289,540	S71,267	$360,807
22	2023		S10.958	$10,958	$310,918	$377,898	$306,631	$71,267	$377,898
23	2024		$10,958	$10,958	$321,876	$395,337	5324.070	S71,267	s395.337
24	2025		S10.958	S10.958	$332,834	s413.132	S341,865	$71,267	$413,132
25	2026		$10.958	S10.958	S243.792	$431.291	$360,024	S71.267	S431,291
26	2027		$10,958	$10,958	$354,750	S449.820	$378,553	S71,267	S449.820
27	2028		$10,958	$10,958	5365.708	$468,727	S397.460	S71,267	$468,727
28	2029		S10.958	$10,958	S376.666	S488.020	$416,753	$71,267	$488,020
29	2030		$10,958	$10,958	$387,624	S507.707	S436.440	S71.267	$507,707
30	2031		S10.958	S10.958	$398,582	s527.795	$456,529	S71,267	$527,795

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 2 - LOCALIZED CONTROLS AND INTEGRATED CONTROLS (OUTFALLS 010, 015, AND THE BALANCE OF OUTFALL 001)

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 Integrated Controls Rock Check Dam Repair	30	ea	$1,000				$30,000	$0	$0	$0	$30,000
2 Integrated Controls Sampling Labor, Mobilization/Demobilization, Supplies	2400	ea	$0	$0.00	$40.00	$0.00	$0	$0	$96,000	$0	$96,000
3 Integrated Controls Performance Sampling - Metals	120	ea	$0	$295.27	$0.00	$0.00	$0	$35,432	$0	$0	$35,432
4 Integrated Controls Perromance Sampling - Pesticides and PCBs	120	ea	$0	$158.36	$0.00	$0.00	$0	$19,003	$0	$0	$19,003
5 Integrated Controls Performance Sampling - Dissolved Solids	120	ea	$0	$12.73	$0.00	$0.00	$0	$1,528	$0	$0	$1,528
6 Integrated Controls Performance Sampling - Suspended Solids	120	ea	$0	$12.73	$0.00	$0.00	$0	$1,528	$0	$0	$1,528
7 Integrated Controls Performance Sampling - Radiological	120	ea	$0	$400.00	$0.00	$0.00	$0	$48,000	$0	$0	$48,000
Subtotal Direct Capital Costs including Subcontract							$30,000	$105,491	$96,000	$0	$231,491
Local Area Adjustment								89%	89%	89%	
							$30,000	$94,098	$85,632	$0	$209,730
Burden @ 30% of Labor Costs									$25,690		$25,690
Total Direct Cost									$111,322	$0	$235,419
Indirects @ 26% of Total Direct Cost									$28,944	$0	$28,944
Total Indirect & Direct Costs											$264,363
Sales Tax @ 6% of Total Indirect & Direct Costs											$5,646
Engineering (Design) @ 6% of Total Indirect & Direct Costs											$15,862
Total Cost											$285,871
Overhead @ 34.879" PGDP Personnel											$29,860
Overhead on Indirect Costs @ 7.62%											$2,206
Total											$317,936

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 008)

Cost Summary

Capital	$1,159,657
O&M (30 years)	$333,836
Total	$1,493,493
Escalated Total Cost'	$1,629,564

[1] 2% per year beginning in 2003

Cost Estimate Assumptions

Costs for Localized Controls are not included in this estimate.

No particulate removal. Storm water will be routed via pipe and ditch to outfall.

Hydraulic components (i.e., drainage pipe and ditch) will be designed to route the peak flow from a 25-year, 24-hour precipitation event.

A soil volume of 6,000 cubic yards will be excavated.

3,000 cubic yards of clean soil will be staged on-site and used as borrow material.

2,000 cubic yards of contaminated soil will be disposed of at an off-site facility.

A total of 5 check dams will be constructed.

Construction will last no more than 12 weeks.

Drainage pipe will operate for 30 years and require cleanout every 10 years.

A new NPDES station will be constructed.

Pricing was based on published values, recent similar job history, and best engineering judgment.

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 008)

CAPITAL COSTS

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Projat Plans	1000	hr	$0	$0.00	$33.79	$0.00	$0	$0	$33,790	$0	$33,790
1.2 Project Scheduling and Procurement	200	hr	$0	$0.00	$33.79	$0.00	$0	$0	$6,758	$0	56,758
2 MOBILIZATION/DEMOBILIZATION											
2.1 Equipment Mob/Demob (Exc., Loader, & Dozer)	10	ea	$0	$0.00	$200.00	$250.00	$0	$0	$2,000	52,500	$4,500
2.2 Mobilize/Demobilize Personnel (3-persons)	10	ea		$375.00	$300.00		$0	$3,750	$3,000	$0	$6,750
2.3 Portable Toilet	3	mo	$74	$0.00	$0.00	$0.00	$223	$0	$0	$0	$223
2.4 Storage Trailer (28'x 10')	3	mo	$98	$0.00	$0.00	$0.00	$295	$0	$0	$0	$295
2.5 Office Trailer (32'x 8')	3	mo	$221	$0.00	$0.00	$0.00	$664	$0	$0	$0	$664
2.6 Site Utilities	3	mo	$1,000	$0.00	$0.00	$0.00	$3,000	$0	$0	$0	$3,000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls	$0	$450.00	$400.00	$155.00	$0	$450	$400	$155	$1,005
3.2 Decon Water Disposal	50	drum	$125	$0.00	$0.00	$0.00	$6,250	$0	$0	$0	56,250
3.3 Decon Water Storage Drums	50	ea	$0	$45.00	$0.00	$0.00	$0	$2,250	$0	$0	52,250
3.4 PPE (3p * 5 days * 12 Weeks)	180	m-day	$0	$30.00	$0.00	$0.00	$0	$5,400	$0	$0	$5,400
3.5 Decontaminate Equipment (Pressure Washer)	6	ea	$0	$0.00	$134.45	$50.00	$0	$0	5807	$300	51,107
4 SITE PREPARATION											
4.1 Erosion Control Fencing	400	lf	$0	$0.23	$1.17	$0.00	$0	$92	$468	$0	$560
4.2 Construction Surveys (2-man crew)	120	day	$648	$0.00	$0.00	$0.00	$77,803	$0	$0	$0	577,803
4.3 Utility Location and Site Delineation/Layout	80	hrs	$0	$0.00	$33.23	$0.00	$0	$0	$2,658	$0	$2,658
4.4 Clearing - Mediuni Brush, Medium Trees, Clear Grub, Haul	5	acre	$0	$0.00	$2,952.00	$2,776.00	$0	$0	$14,760	$13,880	528,640
5 EXCAVATION/BACKFILL											
5.1 Ditch Excdvnlion. Normal Soil. Haul Spoil 1 Mile	6000	cy	$0	$0.00	$1.54	$2.73	$0	$0	59,240	$16,380	$25,620
5.2 Standby. 1 cy Gradall	40	hrs	$0	$0.00	$0.00	$20.14	$0	$0	$0	$806	$806
5.3 Standby. 12 cy. Dump Truck	40	hrs	$0	$0.00	50.00	$14.07	$0	$0	$0	$563	$563
6 DITCH CONSTRUCTION											
6.1 Precast, CIP Base, 4' Diameter, 12' Deep, Manhole	2	ea	$0	$832.73	551069	$220.39	$0	$1,665	$1,021	$441	$3,128
6.3 Corrugated Metal Pipe Culvert 60 in dia	650	lf	$0	$79.22	$0.43	52.27	$0	$51,493	$280	51,476	$53,248
6.5 NPDES Station	1	ea	$100,000	$0.00	$0.00		$100,000	$0	$0	$0	$100,000
6.4 Rock Cover. Riprap. Mediuni (10-200lb)	1000	cy		$15.88	$3.13	52.21	$0	$15,880	$3,130	$2,210	$21,220
7 SITE RESTORATION											
7.1 Import Vegetative Cover Material (Topsoil)	750	cy	$0	$15.00			$0	$11,250	$0	$0	$11,250
7.2 Place/Grade Topsoil (6")	7	day	$0	$0.00	$227.20	$435.00	$0	$0	$1,590	$3,045	$4,635
7.3 Seed Disturbed Area	600	1000sf	$0	$23.00	$7.40	$7.85	$0	$13,800	$4,440	$4,710	$22,950
8 INTEGRATED CONTROLS											
8.1 Rock Cover, Riprap, Mediuni (10 to 200 lb Pieces)	500	cy	$0	$15.88	$3.13	$2.21	$0	$7,940	$1,565	$1,105	$10,610
8.2 105 Mil Geotextile, Nonwoven	1250	sy	$0	$0.78	$0.47	$0.03	$0	$975	$588	$38	$1,600
9 EXCESS SOIL											
9.1 Soil. 5 Miles, Dump Truck. Load/Haul Spoil From Trench	3000	cy	$0.00	$0.00	$1.32	$2.32	$0	$0	$3,960	$6,960	$10,920
10 EXCESS CONTAMINATED SOIL											
10.1 Rail to Envirocare (Clive. Utah). Gondola Car (74.07 cy Per Car)	27	ea	$11,221.00				$302,984	$0	$0	$0	$302,984
10.2 Disposal of LLW at Envirocare of Utah	2000	cy	$140.40				$280,800	$0	$0	$0	$280,800
10.3 Excavate/Load Contaminated Soil (21 cy, 1/4 dozer & 5000' haul)	2000	cy			$0.93	$5.40	$0	$0	$1,860	$10,800	$12,660
Subtotal Direct Capital Costs Including Subcontract							$772,019	$114,945	$92,315	$65,367	$1,044,646
Local Area Adjustment								89%	89%	89%	
							$772,019	$102,531	$82,345	$58,308	$1,015,203
Burden @ 30% of Labor Costs									524,703		$14,703
Total Direct Cast									$107,048	$58,308	$1,039,906
Indirects @ 26% of Total Direct Cost									$27,833	515,160	$42,993

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 008)

Cost Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Total Indirecl & Direct Costs											$1,082,899
Sales Tax @ 6% of Total Indirect & Direct Costs											$6,152
Engineering (Design) @ 6% of Total Indirect & Direct Costs (O&M Costs)											$64,974
Total Cost											$1,154,024
Overhead @ 34.87% PCDP Personnel											52,357
Overhead on Indirect Costs @ 7.62%											53,276
Total											$1,159,657

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 008)

O&M Cost per month = $9,538
O&M Cost per month plus cleanout = S20.138

		Capital	O&M	Total Yearly cost	Total Unescrlated cost	Escalated Total Net Present Wortb @ 2%/yr.	Escalated Net Present Worth @ 2%/yr. - O&M	Escalated Net Present Worth @ 2%/yr. -Capital	Escalated Total Net Present Worth @ 2%/yr.
1	2002	$1,159,657	S9.538	S1,169,195	S1,169.195	S1,169,195	$9,538	S1,159,657	S1,169,195
2	2003		$9,538	$9,538	$1,178,733	$1,202,987	519.664	$1,183,323	$1,202,987
3	2004		$9,538	$9,538	$1,188,271	$1,213.121	S29.798	$1,183,323	$1,213,121
4	2005		$9,538	$9,538	S1, 197.809	S1,223,462	$40,139	$1,183,323	$1,223,462
5	2006		$9,538	$9,538	$1,207,347	SI,234,014	S50.690	$1,183,323	$1,234,014
6	2007		$9,538	$9,538	S1,216,885	51,244,781	$61,458	S1,183,323	SI,244,781
7	2008		$9,538	$9,538	$1,226,423	$1,255,768	$72,445	$1,183,323	$1,255,768
8	2009		$9,538	$9,538	$1,235,961	S1.266.979	583.656	$1,183,323	S1,266,979
9	2010		$9,538	$9,538	$1,245,499	$1,278,419	$95,096	S1,183,323	51,278,419
10	2011		$9,538	$9,538	S1.255.037	$1,290,092	$106,769	$1,183,323	S1,290,092
11	2012		$20,138	S20.138	$1,275,175	$1,315,242	SI31918	$1,183,323	$1,315,242
12	2013		$9,538	$9,538	SI,284,713	$1,327,397	$144,073	51,183,323	$1,327,397
13	2014		$9,538	$9,538	$1,294,251	S1.339.799	$156,476	$1,183,323	$1,339,799
14	2015		$9,538	$9,538	$1,303,789	$1,352,455	S169.132	$1,183,323	$1,352,455
15	2016		$9,538	$9,538	$1,313,327	SI,365,369	$182,046	SI, 183,323	SI,365,369
16	2017		$9,538	$9,538	$1,322,865	$1,378,547	$195,224	$1,183,323	$1,378,547
17	2018		$9,538	$9,538	$1,332,403	$1,391,994	$208,670	SI. 183,323	SI.391,994
18	2019		$9,538	$9,538	S1.341941	$1,405,715	$222,391	S1,183,323	SI,405,715
19	2020		59,538	$9,538	$1,351,479	$1,419,716	$236,392	$1,183,323	SI,419.716
20	2021		$9,538	$9,538	SI,361,017	$1,434,003	$250,679	$1,183,323	S1.434.003
21	2022		S20.138	$20,138	$1,381,155	$1,464,783	$281,459	$1,183,323	$1,464,783
22	2023		$9,538	$9,538	$1,390,693	$1,479,659	$296,335	$1,183,323	$1,479,659
23	2024		$9,538	$9,538	SI.400.231	$1,494,838	s311,515	$1,183,323	$1,494,838
24	2025		$9,538	$9,538	$1,409,769	$1,510.327	$327,004	$1,183,323	$1,510,327
25	2026		$9,538	$9,538	$1,419.307	$1,526,133	5342.809	$1,183,323	$1,526,133
26	2027		$9,538	$9,538	S1.428.845	SI,542,261	5358.937	SI, 183,323	$1,542,261
27	2028		$9,538	$9,538	$1,438,383	$1,558,718	$375,394	$1,183,323	$1,558,718
28	2029		$9,538	$9,538	$1,447,921	$1,575,511	S392.187	$1,183,323	$1,575,511
29	2030		$9,538	$9,538	SI.457.459	$1,592,646	$409,323	$1,183,323	SI,592,646
30	2031		S20.138	S20.138	SI,477,597	SI,629,564	$446,241	$1,183,323	SI,629,564

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 008)

OPERATION AND MAMTENANCE COSTS

				Unit Cost				Extended Cost				
1	Pipe inspection and cleanout	3	ea	$10.000				$30.000	$0	$0	$0	$30,000
2	Sampling Labor. Mobilization/Demobilization, Supplies	2400	ea	$0	$0 00	$40 00	$0 00	$0	$0	$96.000	$0	596.000
3	Performance Sampling - Metals	I20	ea	$0	$295 27	$0 00	$0 00	$0	$35,432	$0	$0	$35,432
4	Performance Sampling - Pesticides and PCBs	I20	ea	$0	$158 36	$0 00	$0 00	$0	$ 19.003	$0	$0	$19,003
	Performance Sampling - Dissolved Solids	I20	ea	$0	$12 13	$0 00	$0 00	$0	$1,528	$0	$0	$1,528
	Performance Sampling - Suspended Solids	120	ea	$0	$12 73	$0 00	$0 00	$0	$1,528	$0	$0	$1,528
	Performance Sampling - Radiological	I20	ea	$0	$400 00	$0 00	$0 00	$0	$48,000	$0	$0	$48,000
5	Integrated Controls - Check Dam Repair	30	ea	$500 00	$0 00	$0 00	$0 00	$15,000	$0	$0	$0	$15,000
Subtotal Direct Capital Costs including Subcontract								$45,000	$105,491	$96,000	$0	$246.491
Local Area Adjustment									89%	89%	89%	
								$45,000	$94,098	$85,632	$0	$224,730
Burden @ 30% of Labor Costs										$25,690		$25.690
Total Direct Cost										$111.322	$0	$250,419
Indirects @ 26% of Total Direct Cost										$28,944	$0	$28,944
Total Indirect & Direct Costs												$279,363
Sales Tax @ 6% of Total Indirect & Direct Costs												$5,646
Engineering (Design) @ 6% of Total Indirect & Direct Costs												$16,762
Total Cost												$301.711
Overhead @ 34.87% PGDP Personnel												$29.860
Overhead on Indirect Costs @ 7.62%												$2,206
Total												$333,836

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 011)

Cost Summary

Capital	$1,288.917
O&M (30 years)	$333,836
Total	$1,622,753
Escalated Total Cost[1]	$1.761,462

[1] **2% per year beginning in 2003**

Cost Estimate Assumptions

Costs for Localized Controls are not included in this estimate.

No particulate removal. Storm water will be routed via pipe and ditch to outfall.

Hydraulic components (i.e., drainage pipe and ditch) will be designed to route the peak flow from a 25-year, 24-hour precipitation event.

A soil volume of 30,000 cubic yards will be excavated.

10,000 cubic yards of clean soil will be staged on-site and used as borrow material.

2,000 cubic yards of contaminated soil will be disposed of at an off-site facility.

A total of 5 check dams will be constructed.

Construction will last no more than 16 weeks.

Drainage pipe will operate for 30 years and require cleanout every 10 years.

A new NPDES station will be constructed.

Pricing was based on published values, recent similar job history, and best engineering judgment.

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 011)

CAPITAL COSTS

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Project Plans	1000	hr	$0	$0.00	$33.79	$0.00	$0	$0	$33,790	$0	$33,790
1.2 Project Scheduling and Procurement	200	hr	$0	$0.00	$33.79	$0.00	$0	$0	$6,758	$0	$6,758
2 MOBILIZATION/DEMOBILIZATION											
2.1 Equipment Mob/Demob (Exc., Loader. & Dozer)	10	ea	$0	$0.00	$200.00	$250.00	$0	$0	$2,000	$2,500	$4,500
2.2 Mobilize/Demobilize Personnel (3-persons)	10	ea		$375.00	$300.00		$0	$3,750	$3,000	$0	$6,750
2.3 Portable Toilet	3	mo	$74	$0.00	$0.00	$0.00	$223	$0	$0	$0	$223
2.4 Storage Trailer (28' x 10')	3	mo	$98	$0.00	$0.00	$0.00	$295	$0	$0	$0	$295
2.5 Office Trailer (32' x 8')	3	mo	$221	$0.00	$0.00	$0.00	$664	$0	$0	$0	$664
2.6 Site Utilities	3	mo	$1,000	$0.00	$0.00	$0.00	$3,000	$0	$0	$0	$3,000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls	$0	$450.00	$400.00	$155.00	$0	$450	$400	$155	$1,005
3.2 Decon Water Disposal	50	drum	$125	$0.00	$0.00	$0.00	$6,250	$0	$0	$0	$6,250
3.3 Decon Water Storage Drums	50	ea	$0	$45.00	$0.00	$0.00	$0	$2,250	$0	$0	$2,250
3.4 PPE (3p * 5 days * 16 Weeks)	240	m-day	$0	$30.00	$0.00	$0.00	$0	$7,200	$0	$0	$7,200
3.5 Decontaminate Equipment (Pressure Washer)	6	ea	$0	$0.00	$134.45	$50.00	$0	$0	$807	$300	$1,107
4 SITE PREPARATION											
4.1 Erosion Control Fencing	400	lf	$0	$0.23	$1.17	$0.00	$0	$92	$468	$0	$560
4.2 Construction Surveys (2-man crew)	120	day	$648	$0.00	$0.00	$0.00	$77,803	$0	$0	$0	$77,803
4.3 Utility Location and Site Delineation/Layout	80	hrs	$0	$0.00	$33.23	$0.00	$0	$0	$2,658	$0	$2,658
4.4 Clearing - Mediuni Brush, Medium Trm. Clear Grub. Haul	5	acre	$0	$0.00	$2,952.00	52,776.00	$0	$0	514,760	$13,880	$28,640
5 EXCAVATION/BACKFILL											
5.1 Ditch Excavation, Normal soil. Haul spoil 1 Mile	30000	cy	$0	$0.00	$1.54	$2.73	$0	$0	SJ6,200	$81,900	$128,100
5.2 Standby. 1 cy Gradall	120	hrs	$0	$0.00	$0.00	$20.14	$0	$0	$0	$2,417	$2,417
5.3 Standby. 12 cy. Dump Truck	120	hrs	$0	$0.00	$0.00	$14.07	$0	$0	$0	$1,688	$1,688
6 DITCH CONSTRUCTION											
6.1 Precast. CIP Base. 4' Diameter. 12' Deep. Manhole	1	ea	$0	$832.73	$510.69	5220.39	$0	$833	$511	$220	$1,564
6.2 Corrugated Metal Pipe Culvert 60 in did	100	lf	$0	$79.22	$0.43	$2.27	$0	57,922	$43	$227	$8,192
6.3 NPDES Station	1	ea	$100,000	$0.00	$0.00		$100,000	$0	$0	$0	$100,000
6.4 Rock Cover. Riprap. Medium (10-200 lb)	1000	cy		$18.88	$3.13	$2.21	$0	$15,880	$3,130	$2,210	521,220
7 SITE RESTORATION											
7.1 Import Vegetative Cover Material (Topsoil)	750	cy	$0	$15.00	$0.00	$0.00	$0	$11,250	$0	$0	$11,250
7.2 Place/Grade Topsoil (6")	7	dry	$0	$0.00	$227.20	$435.00	$0	$0	$1,590	$3,045	$4,635
7.3 Seed Disturbed Area	600	1000 sf	$0	$23.00	$7.40	$7.85	$0	$13,800	$4,440	$4,710	$22,950
8 INTEGRATED CONTROLS											
8.1 Rock Cover, Riprap. Mediuni (10 to 200 lb Pieces)	500	cy	$0	$15.88	$3.13	$2.21	$0	57,940	$1,565	$1,105	$10,610
8.2 105 Mil Geotextile. Nonwovni	1250	sy	$0	$0.78	$0.47	$0.03	$0	$975	$588	$38	$1,600
9 EXCESS SOIL											
9.1 Soil. 5 Miles, Dump Truck. Load/Haul Spoil From Trench	10000	cy	$0.00	$0.00	$1.32	$2.32	$0	$0	513,200	$23,200	$36,400
10 EXCESS CONTAMINATED SOIL											
10.1 Rail to Envtrocare (Clive, Utah) . Gondola Car (74.07 cy Per Car)	27	ea	$11,221.00				$302,984	$0	$0	$0	$302,984
10.2 Disposal of LLW at Envirocare of Utah	2000	cy	$140.40				$280,800	$0	$0	$0	5280,800
10.3 Excavate/Load Contaminated Soil (21 cy. 1/4 dozer & 5000' haul)	2000	cy			$0.93	$5.40	$0	$0	$1,860	$10,800	$12,660
Subtotal Direct Capital Costs including Subcontract							$772,019	$72,342	$137,768	$148,395	$1,130,523
Local Area Adjustment								89%	89%	89%	
							$772,019	$64,529	$122,889	$132,368	$1,091,805
Burden @ 30% of Labor Costs									536,867		$36,867
Total Direct Cost									$159,755	$132,368	$1,128,672
Indirects @ 26% of Total Direct Cost									$41,536	$34,416	$75,952

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS. INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 011)

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Total Indirect & Direct Costs											$1,204,624
Sales Tax @ 6% of Total Indirect & Direct Costs											$3,872
Engineering (Design) @ 6% of Total Indirect & Direct Costs											$72,277
Total Cost											$1,280,773
Overhead @ 34.81% PGDP Personnel											$2,357
Overhead on Indirect Costs @ 7.62%											55,788
Total											$1,288,917

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 011)

O&M Cost per month = $9,538
O&M Cost per month plus cleanout = $20,138

		Capital	O&M	Total Yearly cost	Total Unescalated cost	Escalated Total Net Present Wortb @, 2%/yr.	Escalated Net Present Wortb @, 2%/yr. - O&M	Escalated Net Present Wortb @, 2%/yr. - Capital	Escalated Total Net Present Wortb @, 2%/yr.
1	2002	$1,288,917	$9,538	$1,298.455	$1,298,455	$1,298,455	$9,538	$1,288,917	$1,298,455
2	2003		$9,538	59.538	$1,307,993	$1.334.885	$19,664	$1,315.221	$1,334,885
3	2004		$9,538	$9,538	$1,317,531	$1,345,019	$29,798	$1,315.221	$1,345,019
4	2005		$9,538	$9,538	$1,327,069	$1,355,360	$40,139	$1,315,221	$1,355,360
5	2006		$9,538	$9,538	$1,336,607	$1,365,912	$50,690	$1,315,221	$1,365,912
6	2007		$9,538	$9,538	$1,346,145	$1,376,679	$61.458	$1,315.221	$1,376,679
7	2008		$9,538	$9,538	$1,355,683	$1,387,666	$72.445	$1,315,221	$1,387,666
8	2009		$9,538	$9,538	$1,365,221	$1.398.877	$83,656	$1,315.221	$1,398,877
9	2010		$9,538	$9,538	$1,374,759	$1,410,317	$95.096	$1,315.221	$1,410,317
10	2011		$9,538	$9,538	$1,384,297	$1,421,990	$106.769	$1,315.221	$1.421,990
11	2012		$20.138	$20,138	$1,404,435	$1,447,140	$131,918	$1,315,221	$1,447,140
12	2013		$9,538	$9,538	$1,413.973	$1,459,294	$144,073	$1,315,221	$1.459.294
13	2014		$9,538	$9,538	$1,423,511	$1.471.697	$156,476	$1,315,221	$1.471,697
14	2015		$9,538	$9,538	$1,433,049	$1,484,353	$169.132	$1,315,221	$1,484,353
15	2016		$9,538	$9,538	$1,442,587	$1.497.267	$182,046	$1,315,221	$1,497,267
16	2017		$9,538	$9,538	$1,452,125	$1,510,445	$195,224	$1,315.221	$1,510.445
17	2018		$9,538	$9,538	$1,461,663	$1,523,892	$208,670	$1,315.221	$1,523,892
18	2019		$9,538	$9,538	$1,471,201	$1,537,613	$222.391	$1,315,221	$1,537,613
19	2020		$9,538	$9,538	$1,480,739	$1,551,614	$236,392	$1,315,221	$1,551,614
20	2021		$9,538	$9,538	$1,490,277	$1,565,901	$250,679	$1,315,221	$1,565,901
21	2022		$20,138	$20.138	$1,510.415	$1,596,681	$281,459	$1,315.221	$1,596,681
22	2023		$9,538	$9,538	$1,519,953	$1,611,557	$296,335	$1,315.221	$1,611,557
23	2024		$9,538	$9,538	$1,529,491	$1,626,736	$311,515	$1,315,221	$1,626,736
24	2025		$9,538	$9,538	$1,539,029	$1,642,225	$327,004	$1,315.221	$1,642,225
25	2026		$9,538	$9,538	$1,548,567	$1,658,031	$342,809	$1,315,221	$1,658,031
26	2027		$9,538	$9,538	$1,558,105	$1,674,159	$358,937	$1,315,221	$1,674,159
27	2028		$9,538	$9,538	$1,567,643	$1,690,616	$375,394	$1,315,221	$1,690,616
28	2029		$9,538	$9,538	$1,577,181	$1,707,409	$392,187	$1,315.221	$1,707,409
29	2030		$9,538	$9,538	$1,586,719	$1,724,544	$409.323	$1,315,221	$1,724,544
30	2031		$20,138	$20,138	$1,606,857	$1.761,462	$446,241	$1,315.221	$1,761,462

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 3 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH (OUTFALL 011)

				Unit Cost				Extended Cost			
Cost Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 Pipe Inspection and Cleanout	3	ea	$10.000				$30,000	$0	$0	$0	$30.000
2 Sampling Labor, Mobilization/Demobilization, Supplies	2400	ea	$0	$0 00	$40 00	$0 00	$0	$0	$96,000	$0	$96,000
3 Performance Sampling - Metals	120	ea	$0	$295 21	$0 00	$0 00	$0	$35,432	$0	$0	s35.432
4 Performance Sampling - Pesticides and PCBs	120	ea	$0	$158 36	$0 00	$0 00	$0	$19,003	$0	$0	$19,003
Performance Sampling - Dissolved Solids	I20	ea	$0	$12 73	$0 00	$0 00	$0	$1,528	$0	$0	$1,528
Performance Sampling - Suspended Solids	120	ea	$0	s12 73	$0 00	$0 00	$0	$1.528	$0	$0	$1,528
Performance Sampling - Radiological	I20	ea	$0	$400 00	$0 00	$0 00	$0	$48,000	$0	$0	$48,000
5 Integrated Controls - Check Dam Repair	30	ea	5500.00	$0 00	$0 00	$0 00	$15,000	$0	$0	$0	$15,000
Subtotal Direct Capital Costs including Subcontract							$45,000	$105,491	$96,000	$0	5246.491
Local Area Adjustment								89%	89%	89%	
							545,000	$94,098	$85,632	$0	$224.130
Burden @ 30% of Labor Costs									$25,690		$25,690
Total Direct Cost									$111,322	$0	$250,419
Indirects @ 26% of Total Direct Cost									528.944	$0	528.944
Total Indirect & Direct Costs											$279.363
Sales Tax @ 6% of Total Indirect & Direct Costs											55.646
Engineering (Design) @ 6% of Total Indirect & Direct Costs											$16,762
Total Cost											$301,771
Overhead @ 34.87% PGDP Personnel											$29,860
Overhead on Indirect Costs @ 7.62%											$2,206
Total											$333,836

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 008)

Cost Summary

Capital	52,950,935
O&M (30 years)	**$ 1,970,302**
Total	54.921,237
Escalated Total Cost'	**$5,841,468**

' 2% per year beginning in 2003

Cost Estimate Assumptions

Costs for Localized Controls are not included in this estimate.

Hydraulic components(i.e., ditches, culverts, and spillways) will be designed to route the **peak** flow from a 25-year, 24-hour precipitation event to the basin.

Basin retention design (sedimentation)will be based on the estimated runoff of between a 2-year and 5-year, 24-hour precipitation event (Type II Rainfall distribution and antecedent moisture condition II) The Natural Resource Conservation Service TR-55 and TR-149 methods will be used to estimate volume.

The basin emergency spillway will be designed to pass a 25-year, 24-hour precipitation event

A soil volume of **34,200** cubic **yards** will be excavated. ***16,300*** cubic yards of soil will be reused for the basin construction

17,900 cubic yards of clean soil will be staged on-site and used as borrow material

2.000 cubic yards of contaminated soil will be disposed of at an off-site facility

The basin will have a HDPE liner over clay to minimize seepage through the bottom

Two 10.000 gpm pumps will be used to discharge water from the primary basin to the secondary basin

Particulate removal will be accomplished with gravity settling

Construction will last no more than **22** weeks

Basin will operate for 30 years and require cleanout every 10 years

Operation and maintenance costed to include quarterly monitoring for suspended and dissolved phase metals. PCBs, and radiological constituents. NPDES sampling is not included in this estimate.

Total capacity of 18 acre-ft (15 and 3 acre-ft each for the secondary and primary basins, respectively)

A new NPDES station will be constructed

A new 1000 A outfall ditch will be constructed

Water will free flow out the pond to the new outlet to the new outfall ditch

Storm water flow will initially be routed to a primary basin (200 ft x **300** A x **20 ft)** via inlet piping before being pumped to an elevated secondary basin Storm water would then flow by gravity to a new discharge channel and ditch Storm waste flow would then exit through a new NPDES outfall

A total of 5 check dams will be constructed

Pricing was based on published values, recent similar job history, and best engineering judgment

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 008)

CAPITAL COSTS

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Project Plans	1000	hr	$0	$0.00	$33.79	$0.00	$0	$0	533.790	$0	533.790
1.2 Project Scheduling and Procurement	200	hr	$0	$0.00	$33.79	$0.00	$0	$0	$6.758	$0	$6.758
2 MOBILIZATION/DEMOBILIZATION											
2.1 Equipment Mob/Demob (Exc., Loadn. & Dozer)	10	ea	$0	$0.00	$200.00	$250.00	$0	$0	s2.000	$2.500	s4.500
2.2 Mobilize/Demobilize Personnel (3-persons)	10	ea		$375.00	5300.00		$0	$3.750	$3.000	$0	$6.750
2.3 Portable Toilet	3	mo	$74	$0.00	$0.00	$0.00	5223	$0	$0	$0	5223
2.4 Storage Trailer (28'x 10')	3	mo	$98	$0.00	$0.00	$0.00	$295	$0	$0	$0	$295
2.5 Office Trailer (32' x 8')	3	mo	5221	$0.00	$0.00	$0.00	$664	$0	$0	$0	$664
2.6 Site Utilities	3	mo	$1.000	$0.00	$0.00	$0.00	$3.000	$0	$0	$0	s3.000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls	$0	$450.00	$400.00	$155.00	$0	$450	$400	$155	51.005
3.2 Decon Water Disposal	50	drum	$125	$0.00	$0.00	$0.00	$6.250	$0	$0	$0	$6.250
3.3 Decon Water Storage Drums	50	ea	$0	$45.00	$0.00	$0.00	$0	52.250	$0	$0	$2,250
3.4 PPE (3 p * 5 days * 22 Weeks)	330	niday	$0	$30.00	$0.00	$0.00	$0	$9,900	$0	$0	s9.900
3.5 Decontaminate Equipment (Pressure Washer)	6	ea	$0	$0.00	$134.45	$50.00	$0	$0	5807	$300	$1,107
4 SITE PREPARATION											
4.1 Erosion Control Fencing	5000	lf	$0	$0.23	$1.17	$0.00	$0	$1.150	S5.850	$0	$7.000
4.2 Construction Surveys (2-man crew)	120	day	$648	$0.00	$0.00	$0.00	$77.803	$0	$0	$0	$77.803
4.3 Utility Location and Site Delineation/Layout	80	lirs	$0	$0.00	$33.23	$0.00	$0	$0	$2.658	$0	$2,658
4.4 Clearing - Medium Brush. Medium Trees. Cledr Grub. Haul	5	acre	$0	$0.00	52.952.00	$2.776.00	$0	$0	514.760	513.880	$28.640
5 EXCAVATION/BACKFILL											
5.1 Excavate/Load Soil (21 cy. 1/4 dozer & 1500' haul)	28000	cy	$0	$0.00	$0.33	$1.85	$0	$0	$9,240	$51.800	$61,040
5.2 Standby. 21 cy scraper	70	lirs	$0	$0.00		$37.54	$0	$0	$0	$2.628	52.628
5.3 Wheel Loader. 3 cy	440	hrs	$0	$0.00	$27.20	$56.31	$0	$0	$11.968	524.776	536.744
5.4 Standby. Wheel Loader, 3 cy	70	hrs	$0	$0.00		$14.07	$0	$0	$0	$985	$985
6 BASIN											
6.1 Fencing	6000	ft	$0	$7.25	52.57	$1.83	$0	$43,500	$15,420	$10.980	$69,900
6.2 Liner (HDPE)	96000	sqft	$0	$0.30	$0.37		$0	528.800	$35.520	$0	$64,320
6.3 Maintenance Road and Disposal Road (9" 1-1/2" base gravel)	9130	sy	$0	$8.90	$0.36	$0.69	$0	$81,257	$3.287	$6.300	$90.844
6.4 Inlet Structures (10' h. 10'w. reinforced)	40	lf	$0	$71.00	$143.00	$0.00	$0	52.840	55.720	$0	$8,560
6.5 Corrugated Metal Pipe Culvert 60 in dia	550	lf	$0	s79.22	$0.43	$2.27	$0	$43.571	$237	51.249	$45.056
6.6 Outlet Structures	40	lf	$0	$71.00	$143.00	$0.00	$0	$2.840	$1.720	$0	58.560
6.7 Lighting	75	lamp	$0	$565.00	$132.00	$0.00	$0	$42.375	s9.900	$0	$52.275
6.8 Primary Basin 12 in Structural Slabon Grade	20000	sf	$0	$4.71	$2.54	$0.39	$0	$94,200	550.800	$7,800	5152.800
6.9 Pour & Cure Concrete Retaining Wall 12 in thick	444	cy	$0	$81.38	$29.30	$11.06	$0	536.133	$13,009	s4.911	554.053
6.10 Reinforced Steel. Retaining Wall Rebar	36	ton	$0	$579.14	$418.67	$200.67	$0	$20.849	515.071	57.224	$43.145
6.11 Pour & Cure Concrete Barrier Wall	210	cy	$0	$81.38	$29.30	$11.06	$0	$17,090	$6.153	$2.323	$25,565
6.12 Reinforced Steel. Retaining Wall Rebar	17	ton	$0	557914	$418.67	$200.67	$0	$9,845	$7,117	$3,411	$20.374
6.13 Pump Station (10000 gpm)	2	ls	$30.000	$0.00	$0.00	$0.00	$60.000	$0	$0	$0	$60.000
6.14 Basin Berm	17000	cy	$0	$0.58	53.18	$6.61	$0	$9,860	$54.060	$112,370	$176.290
6.15 Geotextile Fabric	96000	sqft	$0	$0.12	$0.37	$0.00	$0	$11,520	$35.520	$0	$47.040
6.16 Electrical Transformer (500 kVA)	1	ls	$0	$12.600.00	$1.625.00	$345.00	$0	$12,600	$1,625	$345	$14.570
6.17 Overhead Line	3	mile/con	$0	56.275.00	51.300.00	$740.00	$0	$18.825	$3.900	52.220	524.945
6.18 NPDES Station	1	ea	$100,000	$0.00	$0.00		$100.000	$0	$0	$0	$100,000
6.19 Pump Building (Butler building)	600	sf	$35	$0.00	$0.00	$0.00	$21.000	$0	$0	$0	$21.000
7 SITE RESTORATION											
7.1 Import Vegetative Cover Material (Topsoil)	750	cy	$0	$15.00			$0	$11,250	$0	$0	$11.250
7.2 Place/Grade Topsoil (6")	7	day	$0	$0.00	$227.20	$435.00	$0	$0	$1.590	s3.045	$4.635
7.3 Seed Disturbed Area	600	1000 sf	$0	$23.00	$7.40	s7.85	$0	$13.800	$4.440	54.710	$22.950
8 INTEGRATED CONTROLS											
8.1 Rock Cover, Riprap. Medium (10 to 200 lb Pieces)	500	cy	$0	$15.88	$3.13	$2.21	$0	$7.940	51.565	$1.105	$10.610
8.2 105 Mil Geotextile. Nonwoven	1250	sy	$0	$0.78	$0.47	$0.03	$0	$975	$588	$38	$1.600
9 EXCESS SOIL											
9.1 Excavate/Load Excess Soil (21 cy. 1/4 dozer & 5000' haul)	11000	cy	$0.00	$0.00	$0.61	$3.31	$0	$0	56.710	$37,070	$43,780
10 EXCESS CONTAMINATED SOIL											

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL008)

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
10.2 Disposal of LLW at Envirocare of Utah	2000	cy	$140 40				$280.800	$0	$0	$0	5280.800
10 3 Excavate/Load Contaminated Soil (21 cy. 1/4 dozer & 5000' haul)	2000	cy			$0 93	$5 40	$0	$0	$1.860	$10.800	$12.660
11 INITIAL SITE CHARACTERIZATION											
11.1 Mobilize/Demobilize CPT Rig and Crew	I	ca	$0 00	s2.472 00	S0 00	$0 00	$0	S2.472	$0	$0	52.472
11.2 CPT Rig. Includes Labor. Sampling . Punching, Decontamination	26	day	$0 00	$2,472 00	$0 00	$0 W	$0	SM.272	$0	$0	SM.272
11.3 Standby Time for CPT Rig and Crew	32	hr	$0 00	$206 00	$0 00	$0 00	$0	56.592	$0	$0	S6.592
11 4 Decontamination Trailer Rental Tor CPT Rig	5	day	$0 00	$87 55	S0 00	$0 00	$0	$438	$0	$0	$438
11 5 Hydropunch with CPT Rig. Medium Soil	3500	ft	$0 00	s7 72	$0 00	$0 00	$0	s27.020	$0	$0	S27.020
11.6 Grout hole after Hydropunching	350	ft	$0 00	$1 54	$0 00	$0 00	$0	$539	$0	$0	$539
11 7 Soil Sample Analysis	350	ca	$0 00	$1.30000	$0 00	$0 00	$0	$455,000	$0	$0	$455,000
Subtotal Direct Capital Costs Including Sobcontract							$853.019	$1.083.903	S371.044	$3 12.924	$2.620.889
Local Area Adjustment								89%	89%	89%	
							S853.019	$966.841	S330.971	$279.128	S2.429.959
Burden @ 30% of Labor Costs									599.291		$99.291
Total Direct Cost									$430.263	S279.128	$2.529.251
Indirects @ 26% of Total Direct Cost									$111.868	S72.573	$184.442
Total Indirect & Direct Costs											$2.713.692
Sales Tax @ 6% of Total Indirect & Direct Costs											$58.010
Engineering (Design) @ 6% of Total Indirect & Direct Costs											S162.822
Total Cost											$2.934.524
Overhead @ 34.87% PGDP Personnel											S2.357
Overhead on Indirect Costs @ 7.62%											$14.054
Total											S2.950.935

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OU'

O&M Cost per month = $44,474
O&M Cost per month plus cleanout = S256.477

		Capital	O&M	Total Yearly cost	Total Unescalated Cost	Escalated Total Net Present Worth @ 2%/yr.	Escalated Net Present Worth @ 2%/yr. - O&M	Escalated Net Present Worth @ 2%/yr. -Capital	Escalated Total Net Present Worth @ 2%/yr.
1	2002	$2,950,935	$44,474	$2,995,409	$2,995,409	$2,995,409	S44.474	52,950,935	$2,995,409
2	2003		s44.474	s44.474	$3,039,883	$3,102,848	S91,689	$3,011,158	$3,102,848
3	2004		S44.474	$44,474	$3,084,357	$3,150,100	S138,942	$3,011,158	$3,150,100
4	2005		$44,474	$44,474	$3,128,831	$3,198,318	S187,159	S3.011.158	$3,198,318
5	2006		S44.414	S44.474	$3,173,305	$3,247,519	$236,361	$3,011,158	$3,247,519
6	2007		$44,474	S44.414	$3,217,779	$3,297,724	$286,566	$3,011,158	$3,297,724
7	2008		S44.474	$44,474	$3,262,253	$3,348,954	S337.796	$3,011.158	$3,348,954
8	2009		$44,474	S44.474	$3,306,727	$3,401,229	$390,071	$3,011,158	$3,401,229
9	2010		S44.414	544.474	$3,351.201	S3.454.572	S443.414	$3,011,158	53,454,512
10	2011		S44.474	$44,474	S3.395.675	S3.509.003	S497.844	S3.011.158	$3,509,003
11	2012		S256.477	S256.477	$3,652,152	$3,829,306	$818,148	$3,011,158	$3,829,306
12	2013		$44,474	S44.474	$3,696,626	S3.885.981	$874,823	$3,011,158	$3,885,981
13	2014		$44,474	$44,474	$3,741,100	$3,943,813	5932.655	$3,011,158	$3,943,813
14	2015		544.474	S44.474	$3,785,574	$4,002,825	S991,667	$3,011,158	$4,002,825
15	2016		$44,474	S44.474	$3,830,048	$4,063,042	$1,051,884	$3,011,158	$4,063,042
16	2017		S44.474	s44.474	$3,874,522	S4.124.487	$1,113,329	$3,011,158	$4,124,487
17	2018		$44,474	$44,474	S3.918,996	$4,187,186	$1.176,028	$3,011,158	$4,187,186
18	2019		s44.474	S44.474	$3,963,470	$4,251,165	$1,240,007	$3,011,158	$4.251,165
19	2020		$44,474	S44.474	$4.001.944	$4,316.450	$1,305,292	$3,011,158	$4,316,450
20	2021		S44.474	$44,474	$4,052,418	$4,383.067	$1.371.909	$3,011,158	$4,383,067
21	2022		$256,477	S256.477	$4,308,895	$4.775.080	$1,163,922	53.011,158	$4,775,080
22	2023		$44,474	$44,474	54,353,369	$4,844,444	$1,833,286	$3,011,158	$4,844,444
23	2024		S44.474	S44.414	$4,397,843	$4.915.222	$1,904,065	$3,011,158	$4.915,223
24	2025		$44,474	544,414	$4,442,317	$4,987.447	$1,976,289	$3,011,158	$4,987,447
25	2026		$44,474	544.474	$4.486.791	$5.061,145	$2,049,987	$3,011,158	$5,061,145
26	2027		$44,474	S44.474	54.531,265	$5,136.347	$2,125,188	$3,011,158	$5,136,347
21	2028		$44,474	s44.474	$4,575,739	$5.213,083	$2,201,925	$3,011,158	$5,213,083
28	2029		$44,474	S44.474	$4,620,213	$5.291,386	$2,280,228	$3,011,158	$5,291,386
29	2030		S44.474	$44,474	$4,664,687	$5,371,286	$2,360,128	$3,011,158	$5,371,286
30	2031		S256.417	$256,477	54.921,164	$5,841,468	$2,830,310	$3,011,158	$5,841,468

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 008)

	Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1	Basin Operation Energy - Electric	600,000	kWh	$0.06				$36.000	$0	$0	$0	$36,000
2	Basin Operation Labor, Mobilization/Demobilization, Supplies	1560	wk			s400		$0	$0	$624,000	$0	$624,000
3	Basin Cleanout	3	ea	$200,000				$600,000	$0	$0	$0	$600,000
4	Basin Performance Sampling - Metals	120	ea		$295.27			$0	535,432	$0	$0	$35,432
	Basin Performance Sampling - Pesticides and PCBs	120	ea		$158.36			$0	$19,003	$0	$0	$19,003
	Basin Performance Sampling - Dissolved Solids	120	ea		$12.73			$0	$1,528	$0	$0	$1,528
	Basin Performance Sampling - Suspended Solids	120	ea		$12.73			$0	$1,528	$0	$0	$1,528
	Basin Performance Sampling - Radiological	120	ea		s400.00			$0	$48,000	$0	$0	$48,000
5	Integrated Controls - Check Dam Repair	30	ea	s500.00	$0.00	$0.00	$0.00	$15,000	$0	$0	$0	$15.000
	Subtotal Direct Capital Costs Including Subcontract							$651,000	$105,491	$624,000	$0	$1,380,491
	Local Area Adjustment								89%	89%	89%	
								$651,000	$94,098	$556,608	$0	$1,301,706
	Burden @ 30% of Labor Costs									$166,982		$166,982
	Total Direct Cost									$723,590	$0	$1,468,688
	Indirects @ 26% of Total Direct Cost									$188,134	$0	$188,134
	Total Indirect & Direct Costs											$1,656,822
	Sales Tax @ 6% of Total Indirect & Direct Costs											$5,646
	Engineering (Design) @ 6% of Total Indirect & Direct Costs											$99,409
	Total Cost											$1,761,877
	Overhead @ 34.87% PGDP Personnel											$194,089
	Overhead on Indirect Costs @ 7.62%											$14,336
	Total											$1,970,302

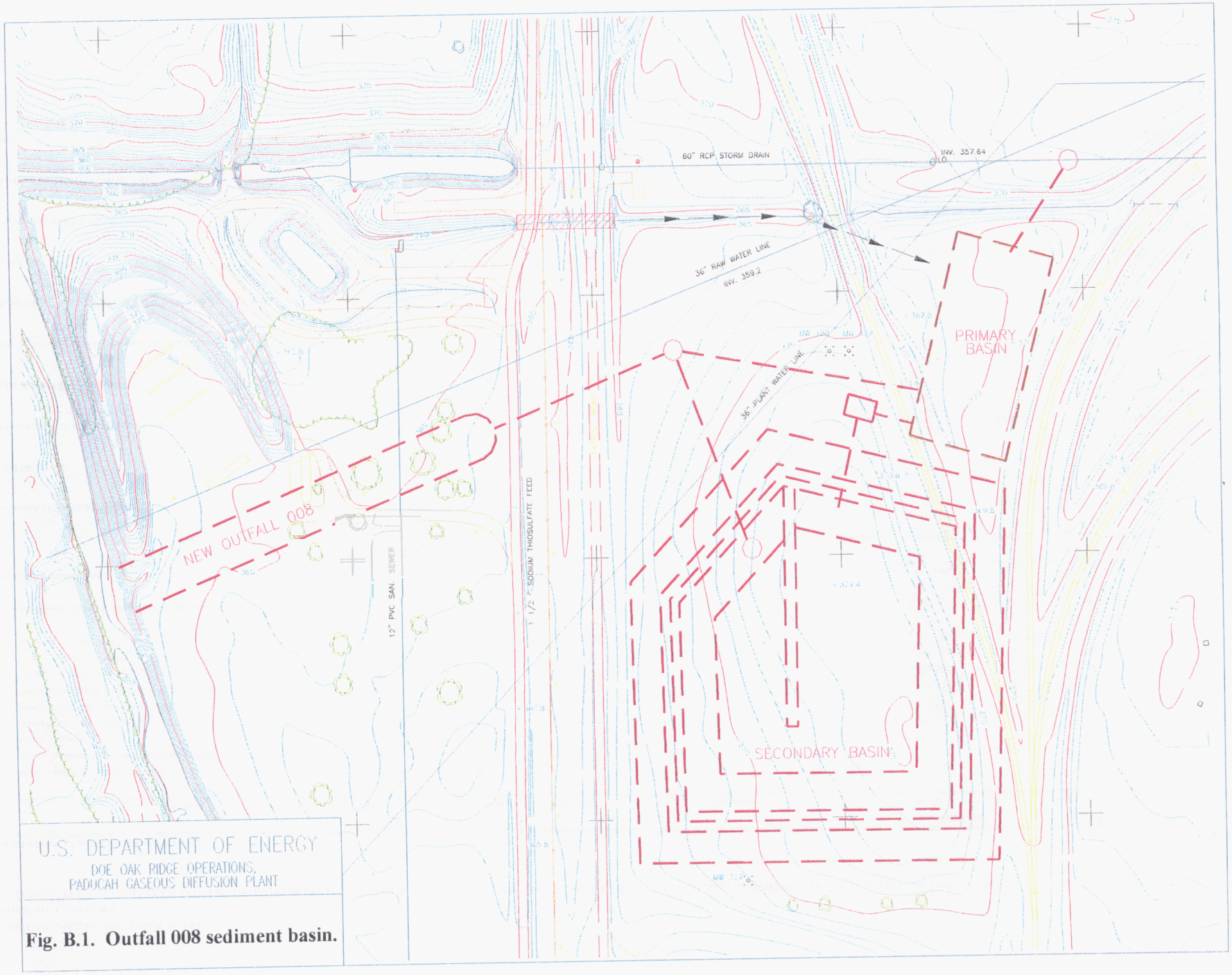


Fig. B.1. Outfall 008 sediment basin.

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 011)

Cost Summary

Capital	$2,172,159
O&M (30 years)	$1,811,302
Total	$3,983,461
Escalated Total Cost'	55,046,799

[1] 2% per year beginning in 2003

Cost Estimate Assumptions

Costs for Localized Controls are not included in this estimate

Hydraulic components(i.e., ditches. culverts, and spillways) will be designed to route the peak flow from a 25-year, 24-hour precipitation event to the basin.

Basin retention design (sedimentation) will be based on the estimated runoff from a 10-year.24-hour precipitation event (Type II Rainfall distribution and antecedent moisture condition II). The Natural Resource Conservation Service TR-55 and TR-149 methods will be used to estimate volume.

The basin emergency spillway will be designed to pass a 25-year, 24-hour precipitation event

A soil volume of 40,000 cubic yards will be excavated

40,000 cubic yards of clean soil will be staged on-site and used as borrow material

2,000 cubic yards of contaminated soil will be disposed of at an off-site facility

The basin will have a HDPE liner over clay to minimize seepage through the bottom

Particulate removal will be accomplished with gravity settling

Construction will last no more than 22 weeks

Basin will operate for 30 years and require cleanout every 10 years

Operation and maintenance costed to include quarterly monitoring for suspended and dissolved phase metals, PCBs, and radiological constituents NPDES sampling is not included in this estimate

Total capacity of approximately 10 acre-ft

A new NPDES station will be constructed
A new 1000 ft outfall ditch will be constructed
Water will free flow out the pond to the new outlet to the new outfall ditch

Storm water flow will be routed to a primary basin via inlet ditch and gravity flow to the secondary basin The secondary basin flow would be discharged to a new discharge channel to a new ditch Storm water flow would then exit through a new NPDES Outfall.

A total of 5 check dams will be constructed

Pricing was based on published values, recent similar job history, and best engineering judgment

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 011)

CAPITAL COSTS

Cost Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Coat Subcontract	Extended Coat Material	Extended Coat Labor	Extended Coat Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Project Plans	1000	hr	$0	$0.00	$33.79	$0.00	$0	$0	533.790	$0	533.790
1.2 Project Scheduling and Procurement	200	hr	$0	$0.00	$33.79	$0.00	$0	$0	$6.758	$0	$6.758
2 MOBILIZATION/DEMOBILIZATION											
2.1 Equipment Mob/Demob (Exc., Loader, & Dozer)	10	ea	$0	$0.00	$200.00	$250.00	$0	$0	$2,000	$2.500	54.500
2.2 Mobilize/Demobilize Personnel (3-persons)	10	ea		$375.00	$300.00		$0	$3,750	$3.000	$0	$6.750
2.3 Portable Toilet	3	mo	$74	$0.00	$0.00	$0.00	$223	$0	$0	$0	$223
2.4 Storage Trailer (28' x 10')	3	mo	$98	$0.00	$0.00	$0.00	$295	$0	$0	$0	$295
2.5 Office Trailer (32' x 8')	3	mo	$221	$0.00	$0.00	$0.00	$664	$0	$0	$0	$664
2.6 Site Utilities	3	mo	$1,000	$0.00	$0.00	$0.00	$3,000	$0	$0	$0	$3.000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls	$0	$450.00	$400.00	$155.00	$0	$450	$400	$155	$1.005
3.2 Decon Water Disposal	50	drum	$125	$0.00	$0.00	$0.00	56.250	$0	$0	$0	56.250
3.3 Decon Water Storage Drums	50	ea	$0	$45.00	$0.00	$0.00	$0	$2.250	$0	$0	$2.250
3.4 PPE (3 p * 5 days * 22 Weeks)	330	m-day	$0	$30.00	$0.00	$0.00	$0	$9.900	$0	$0	$9.900
3.5 Decontaminate Equipment (Pressure Washer)	6	ea	$0	$0.00	$134.45	$50.00	$0	$0	$807	$300	$1.107
4 SITE PREPARATION											
4.1 Erosion Control Fencing	5000	lf	$0	$0.23	$1.17	$0.00	$0	51.150	$5,850	$0	$7,000
4.2 Construction Surveys (2-man crew)	120	day	$648	$0.00	$0.00	$0.00	$77.803	$0	$0	$0	$77.803
4.3 Utility Location and Site Delineation/Layout	80	hrs	$0	$0.00	$33.23	$0.00	$0	$0	52.658	$0	$2.658
4.4 Clearing - Medium Brush, Medium Trees, Clear Grub. Haul	5	acre	$0	$0.00	$2.952.00	$2.776.00	$0	$0	$14.760	$13.880	528.640
5 EXCAVATION/BACKFILL											
5.1 Excavate/Load Soil (21 cy, 1/4 dozer & 1500' haul)	28500	cy	$0	$0.00	$0.33	$1.85	$0	$0	59.405	$52.725	$62.130
5.2 Standby, 21 cy scraper	165	hrs	$0	$0.00		$37.54	$0	$0	$0	56.194	$6.194
5.3 Wheel Loader, 3 cy	1000	hrs	$0	$0.00	$27.20	$56.31	$0	$0	$27,200	$56,310	583.510
5.4 Standby, Wheel Loader, 3 cy	165	hrs	$0	$0.00		$14.07	$0	$0	$0	$2.322	52.322
6 BASIN											
6.1 Fencing	6000	ft	$0	$7.25	$2.57	$1.83	$0	$43.500	515.420	$10.980	$69.900
6.2 Liner (HDPE)	50000	sqft	$0	$0.30	$0.37		$0	$15.000	$18.500	$0	533.500
6.3 Maintenance Road and Disposal Road (9" 1-1/2" base gravel)	9130	sy	$0	$8.90	$0.36	$0.69	$0	$81.257	$3,287	$6.300	$90.844
6.4 Corrugated Metal Pipe Culvert 24 in dia	400	lf	$0	$39.60	$0.43	$2.27	$0	$15.840	$172	$908	$16.920
6.5 Outlet Structures	40	lf	$0	$71.00	$143.00	$0.00	$0	$2,840	55.720	$0	$8.560
6.6 Lighting	75	lamp	$0	$565.00	$132.00	$0.00	$0	$42.375	$9.900	$0	$52.275
6.7 Corrugated Metal Pipe Culvert with Headwalls 150 ft complete, 24 in	1	ea	$0	$8,526.00	$1.59700	$843.32	$0	$8,526	$1,597	$843	$10,966
6.8 Geotextile Fdbric	50000	sqft	$0	$0.12	$0.37	$0.00	$0	$6.000	$18,500	$0	$24.500
6.9 Electrical Transformer (500 kVA)	1	ls	$0	$12,600.00	$1.625.00	$345.00	$0	$12,600	$1.625	5345	$14.570
6.10 Overhead Line	3	mile/con	$0	$6.275.00	$1.30000	$740.00	$0	$18.825	$3.900	52.220	$24.945
6.11 NPDES Station	1	ea	$100.000	$0.00	$0.00		$100.000	$0	$0	$0	$100.000
6.13 Maintenance Building (Butler building)	600	sf	$35	$0.00	$0.00	$0.00	$21.000	$0	$0	$0	$21.000
7 SITE RESTORATION											
7.1 Import Vegetative Covn Material (Topsoil)	525	cy	$0	$15.00			$0	$7,875	$0	$0	$7.875
7.2 Place/Grade Topsoil (6")	5	day	$0	$0.00	$227.20	$435.00	$0	$0	$1,136	$2.175	$3.311
7.3 Seed Disturbed Area	435.6	1000 sf	$0	$23.00	$2.40	57.85	$0	$10.019	$3.223	$3.419	$16.662
8 INTEGRATED CONTROLS											
8.1 Rock Cover, Riprap, Medium (10 to 200 lb Pieces)	500	cy	$0	$15.88	$3.13	$2.21	$0	$7.940	$1.565	$1.105	$10.610
8.2 105 Mil Geotextile, Nonwoven	1250	sy	$0	$0.78	$0.47	$0.03	$0	$975	$588	$38	$1.600
9 EXCESS SOIL											
9.1 Excavate/Load Excess Soil (21 cy, 1/4 dozer & 5000' haul)	16500	cy	$0.00	$0.00	$0.61	$3.37	$0	$0	$10.065	$55,605	$65,670
10 EXCESS CONTAMINATED SOIL											
10.1 Rail to Envirocare(Clive, Utah) . Gondola Car (74.07 cy Per Car)	27	ea	$11.221.00				$302.984	$0	$0	$0	$302.984
10.2 Disposal of LLW at Envirocare of Utah	2000	cy	$140.40				5280.800	$0	$0	$0	5280.800
10.3 Excavate/Load Contaminated Soil (21 cy, 1/4 dozer & 5000' haul)	2000	cy			$0.93	$5.40	$0	$0	$1,860	510.800	$12.660
11 INITIAL SITE CHARACTERIZATION											
11.1 Mobilize/Demobilize CPT Rig and Crew	1	ea	$0.00	52.472.00	$0.00	$0.00	$0	$2.472	$0	$0	52.472
11.2 CPT Rig, Includes Labor, Sampling, Punching, Decontamination	21	dry	$0.00	52.472.00	$0.00	$0.00	$0	551.912	$0	$0	$51.912

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH. KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 011)

CAPITAL COSTS

Cost Item	Quantity	Unit	Unit Cost Sobcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
II 3 Standby Time for CPT Rig and Crew	24	hr	$0 00	$206 00	so00	so00	$0	s4.944	$0	$0	s4.944
i I 4 Decontamination Trailer Rental for CPT Rig	5	day	$0 00	$87 55	so00	$0.00	$0	$438	$0	$0	$438
i I 5 Hydropunch with CPT Rig. Medium Soil	2770	n	$0 00	$7 72	$0.00	so00	$0	$21.384	$0	$0	$21.384
Ii 6 Grout hole after Hydropunching	277	ft	$0 00	$1 54	so00	so00	$0	$427	$0	$0	$427
Ii 7 Soil Sample Analysis	277	ea	$000	$1,300.00	$0.00	so00	$0	$360,100	$0	$0	$360,100
Subtotal Direct Capital Carts Including Sobcontract							5793.019	$732.749	$203.686	$229,124	$1.958.577
Local Area Adjustment								89%	89%	89%	
							$793,019	$653.612	$181,688	$204,378	$1.832.697
Burden @ 30% of Labor Costs									s54.506		$54.506
Total Direct Cost									$236,194	$204,378	$1,887.203
Indirects @ 26% of Total Direct Cart									$61,410	553.138	$114.549
Total Indirect & Direct Costs											$2.001.752
Sales Tax @ 6% of Total Indirect & Direct Carts											$39,217
Engineering (Design) @ 6% of Total Indirect & Direct Costs (O&M Costs)											$120.105
Total Cost											$2.161.074
Overhead @ 34.87% PGDP Personnel											$2,357
Overhead on Indirect Costs @ 7.62%											58.729
Total											$2.172.159

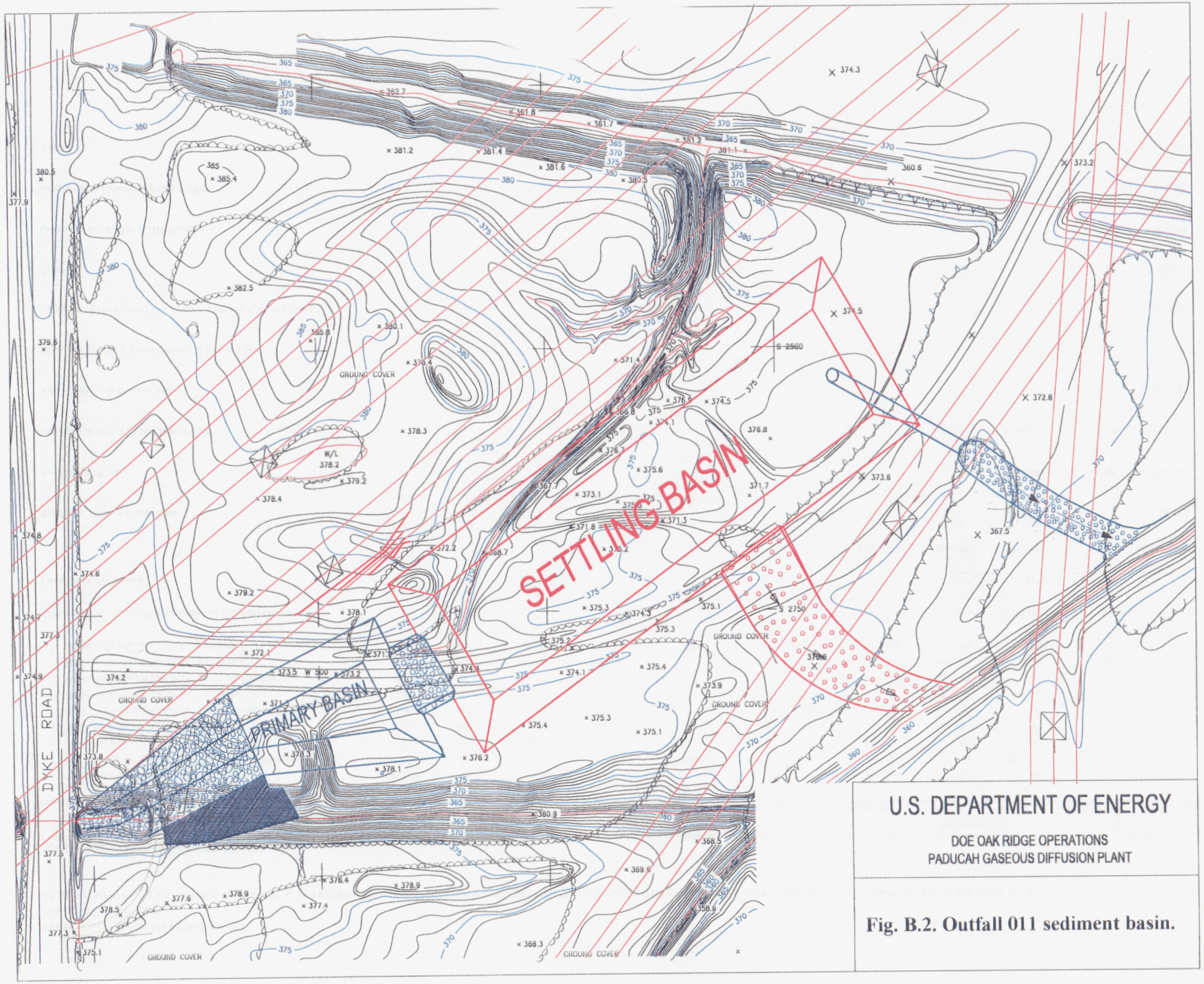
PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OU

O&M Cost per month = S44.474
O&M Cost per month plus cleanout = S256.477

		Capital	O&M	Total Yearly cost	Total Unescalated cost	Escalated Total Net Present Worth @ 2%/yr.	Escalated Net Present Worth @ 2%/yr. - O&M	Escalated Net Present Worth @ 2%/yr. - Capital	Escalated Total Net Present Worth @ 2%/yr.
1	2002	$2,172,159	$44,474	$2,216,633	$2,216,633	$2,216,633	$44,474	$2,172,159	$2,216.633
2	2003		S44.474	$44,474	$2,261,107	$2,308,178	$91,689	$2,216,488	S2.308,178
3	2004		$44,474	$44,474	$2,305,581	$2,355,431	$138,942	$2,216,488	52,355,431
4	2005		$44,474	$44,474	$2,350,055	$2,403,648	$187,159	$2,216,488	$2,403,648
5	2006		$44,474	$44,474	S2.394.529	$2,452,849	$236,361	S2.216,488	$2,452,849
6	2007		$44,474	$44,474	$2,439,003	$2,503,054	$286,566	$2,216,488	$2,503,054
7	2008		S44.474	$44,474	S2.483.477	$2,554,284	$337,796	$2,216,488	$2,554,284
8	2009		$44,474	$44,474	$2,527,951	$2,606,560	$390,071	S2.216.488	$2,606,560
9	2010		$44,474	$44,474	S2.512.425	$2,659,902	$443,414	52216,488	$2,659,902
10	2011		$44,474	S44.474	S2.616,899	$2,714,333	S497.844	$2,216,488	$2,714,333
11	2012		$256,477	$256,477	$2,873,376	$3,034,636	$818,148	$2,216,488	$3,034,636
12	2013		$44,474	S44.474	$2,917,850	$3,091,312	$874,823	$2,216,488	$3,091,312
13	2014		544.474	$44,474	$2,962,324	$3,149,143	$932,655	$2,216.488	$3,149,143
14	2015		$44,474	S44.474	$3,006,798	$3,208,156	s991,667	$2,216,488	S3.208,156
I5	2016		544.414	S44.474	$3,051,272	S3.268.372	S1,051,884	$2,216,488	$3,268,372
16	2017		$44,474	$44,474	$3,095,746	$3,329,817	$1,113,329	$2,216,488	$3,329,817
17	2018		$44,474	$44,474	$3,140,220	$3,392,517	$1,176,028	$2,216,488	$3,392,517
18	2019		$44,474	$44,474	S3.184.694	S3.456.496	$1,240,007	S2.216.488	S3.456.496
19	2020		$44,474	$44,474	53,229,168	$3,521,780	$1,305,292	$2,216,488	S3.521.780
20	2021		544.474	S44.474	$3,273,642	S3.588.397	$1,371,909	$2,216,488	$3,588,397
21	2022		S256.477	$256,477	$3,530,119	$3,980,410	$1,763,922	$2,216,488	S3.980.410
22	2023		S44.474	544.414	$3,574,593	S4.049.774	$1,833,286	$2,216,488	$4,049,774
23	2024		$44,474	$44,474	**$3,619,067**	$4,120,554	$1,904,065	52,216,488	$4,120,554
24	2025		S44.474	$44,474	$3,663,541	$4,192,777	$1,976,289	$2,216,488	S4.192.777
25	2026		$44,474	$44,474	$3,708,015	$4,266,475	$2,049,987	$2,216,488	$4,266,475
26	2027		$44,474	S44.474	$3,752,489	$4,341,677	$2,125,188	$2,216,488	S4.341,677
27	2028		S44.474	$44,474	$3,796,963	$4,418,413	52,201,925	$2,216,488	$4,418,413
28	2029		S44.474	$44,474	S3.841.437	$4,496,716	$2,280,228	$2,216,488	$4,496,716
29	2030		S44.474	$44,474	$3,885,911	S4.576.617	$2,360,128	$2,216,488	$4,576,617
30	2031		S256.477	S256.417	$4,142,388	S5.046.799	$2,830,310	$2,216,488	$5,046,799

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KENTUCKY
ALTERNATIVE 4 - LOCALIZED CONTROLS, INTEGRATED CONTROLS, AND SYSTEM CONTROLS (NEW OUTFALL DITCH AND SEDIMENT CONTROL BASIN (OUTFALL 011)

				Uuit cost				Exteuded Cost				
Cost Item	Quantity	Unit	Subcoutract	Material	Labor	Equipmeut	Subcoutract	Material	Labor	Equipment	Subtotal
1 Basin Operation Energy - Electric	600,000	kWh	$0.06				S36.000	S0	SO	SO	$36,000
2 Basin Operation Labor. Mobilization/Demobilization, Supplies	1560	wk			s400		SO	S0	$624,000	SO	$624,000
3 Basin Cleunout	3	ea	$150,000				$450,000	SO	$0	SO	$450,000
4 Basin Perromance Sampling - Metals	120	ea		S295.27			SO	535,432	$0	SO	$35,432
Basin Performance Sampling - Pesticides and PCBs	120	ea		S158.36			SO	S19,003	SO	SO	S19.003
Basin Perromance Sampling - Dissolved Solids	I20	ea		S12.73			SO	$1.528	SO	$0	$1,528
Basin Perromance Sampling - Suspended Solids	I20	ea		$ 12.73			SO	$1,528	S0	SO	$1,528
Basin Perromance Sampling - Radiological	I20	ea		MOO.OO			S0	$48,000	$0	SO	$48,000
5 Integrated Controls - Check Dam Repair	30	ea	$500.00	S0.00	SOOO	$0.00	$15,000	SO	$0	SO	$15,000
Subtotal Dlreet Capital Costs including Subcoutract							$501,000	$105,491	$624,000	SO	$1,230,491
Local Area Adjustment								89%	89%	89%	
							$501,000	$94,098	$556,608	$0	$1,151,706
Burden @ 30% of Labor Costs									$166,982		$166,982
Total Direct Cost									$723,590	$0	$1,318,688
Indirects @ 26% of Total Direct Cost									$ 188,134	$0	$188,134
Total ludirect & Direct Costs											S1,506,822
Sales Tax @ 6% of Total Indirect & Direct Costs											$5,646
Engiueering (Design) @ 6% of Totul Indirect & Direct Costs											S90.409
Total Cost											51,602,877
Overhead @ 34.87% PGDP Personnel											$ 194,089
Overhead on Indirect Costs @ 7.62%											$14,336
Total											$1,811,302



U.S. DEPARTMENT OF ENERGY

DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

Fig. B.2. Outfall 011 sediment basin.

APPENDIX C

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action

Action	Requirements	Prerequisite	Citation
	Site Preparation, construction, and excavation activities		
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne. Reasonable precautions shall include, but are not limited to the following:	Fugitive emissions from land-disturbing activities (e.g., excavation, construction)—applicable.	401 KAR 63:010 Section 3(1)
	• Use, where possible, of water or chemicals for control of dust in demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land;		401 KAR 63:010 Section 3(1)(a)
	• Application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces which can create airborne dusts; and		401 KAR 63:010 Section 3( )(b)
	• Covering at all times when in motion, open bodied trucks transporting materials likely to become airborne.		401 KAR 63:010 Section 3( )(d)
	Shall not cause or permit the discharge of visible fugitive dust beyond the lot line on which emission originates.		401 KAR 63:010 Section 3(2)
Activities causing radionuclide emissions	Exposures to the public from all radiation sources released into atmosphere from DOE facility shall not cause EDE > 10 mrem (0.1 mSv) per year.	Radionuclide emissions from point sources as well as fugitive emissions at a DOE facility—applicable.	40 CFR 61.92
Activities causing stormwater runoff	• Shall provide a narrative of location, including a map, and nature of the construction activity;	Operation of an existing or new storm water discharge associated with construction activity at industrial sites - disturbance of 5 acres total—applicable; < 5 acres—relevant and appropriate.	401 KAR 5:060 Section 12 (2)(a)(2)
	• Total area of the site and the area of the site expected to undergo excavation;		401 KAR 5:060 Section 12 (2)(a)(2)(a)
	• Proposed measures, including best management practices, to control pollutants in storm water discharges during and after construction, including a brief description of applicable state or local erosion and sediment control requirements;		401 KAR 5:060 Section 12 (2)(a)(2)(c) and (d)
	• An estimate of the runoff coefficient of the site and the increase in impervious area after the construction, the nature of the fill material and existing data describing the soil or quantity of the discharge; and		401 KAR 5:060 Section 12 (2)(a)(2)(e)
	• The name of the receiving water.		401 KAR 5:060 Section 12 (2)(a)(2)(f)
	Water treatment – coiitaminated stormwater, collected leachate		
Discharge of contaminated stormwater	Absorbed dose to native animal aquatic organisms must not exceed 1 rad/day.	Discharge of radioactive materials in liquid waste to surface water at a DOE facility—TBC.	DOE Order 5400.5(II)(3)(a)(5)

Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
		Waste generation/management	
Characterization of solid waste (e.g., contaminated PPE, equipment, wastewater)	Must determine if that waste is hazardous waste or if waste is excluded under 40 CFR 261.4 (401 KAR 32:010 Section 4); and	Generation of solid waste as defined in 40 CFR 261.2 (401 KAR 31:010 Section 2)— **applicable.**	40 CFR 262.11(a) 401 KAR 32:010 Section 2(1)
	Must determine if waste is listed under 40 CFR Part 261 (401 KAR 31:040); or		40 CFR 262.11(b) 401 KAR 32:010 Section 2(2)
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used. If waste is determined to be hazardous, it must be managed in accordance with pertinent provisions of 40 CFR 261-268 (401 KAR Chapters 31, 34, 35, 36, 37, 38, and 43).		40 CFR 262.11(c) and (d) 401 KAR 32:010 Sections 3 and 4
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) which at a minimum contains all the information which must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268 (401 KAR Chapters 34 and 37).	Generation of RCRA hazardous waste for storage, treatment or disposal — **applicable.**	40 CFR 264.13(a)(1) 401 KAR 34:020 Section 4(1)(a)
	Must determine if the waste is restricted from land disposal under 40 CFR 268 (401 KAR Chapter 37) *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste.		40 CFR 268.7 401 KAR 37:010 Section 7
Characterization of LLW (e.g., contaminated PPE, equipment, wastewater)	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility.	Generation of LLW for storage or disposal at a DOE facility—**TBC.**	DOE M 435.1-1(IV)(I)
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)
	• physical and chemical characteristics;		DOE M 435.1-1 (IV)(I)(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1 (IV)(I)(2)(b)
	• weight of the container and contents;		DOE M 435.1-1 (IV)(I)(2)(c)
	• identities, activities, and concentrations of major radionuclides;		DOE M 435.1-1 (IV)(I)(2)(d)
	• characterization date;		DOE M 435.1-1 (IV)(I)(2)(e)
	• generating source; and		DOE M 435.1-1 (IV)(I)(2)(f)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives.		DOE M 435.1-1 (IV)(I)(2)(g)
Management of PCB waste (e.g., contaminated PPE, equipment, wastewater)	Any person storing or disposing of PCB waste must do so in accordance with 40 CFR 761, Subpart D.	Generation of waste containing PCBs at concentrations 250 ppm — **applicable.**	40 CFR 761.50(a)

Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found.	Generation of PCB remediation waste as defined in 40 CFR 761.3 — **applicable.**	40 CFR 761.61
	Storage		
Temporary storage of hazardous waste in containers (e.g., PPE, rags, etc.)	A generator may accumulate hazardous waste at the facility provided that:	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 (401 KAR 30:005 Section 1) — **applicable.**	40 CFR 262.34(a) 401 KAR 32:030 Section 5
	• waste is placed in containers that comply with 40 CFR 265.171-173 (Subpart I) (401 KAR 35:180, 35:275, 35:280, and 35:281); and		40 CFR 262.34(a)(1)(i) 401 KAR 32:030 Section 5(1)(a)
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container;		40 CFR 262.34(a)(2) 401 KAR 32:030 Section 5(1)(b)
	• container is marked with the words "hazardous waste" or;		40 CFR 262.34(a)(3) 401 KAR 32:030 Section 5(1)(c)
	• container may be marked with other words that identify the contents.	Accumulation of 55 gal or less of RCRA hazardous waste at or near any point of generation — **applicable.**	40 CFR 262.34(c)(1) 401 KAR 32:030 Section 5(3)(a)
Use and management of hazardous waste in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition;	Storage of RCRA hazardous waste in containers — **applicable.**	40 CFR 264.171 401 KAR 34:180 Section 2
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired;		40 CFR 264.172 401 KAR 34:180 Section 3
	Keep containers closed during storage, except to add/remove waste; and		40 CFR 264.173(a) 401 KAR 34:180 Section 4(1)
	Open, handle and store containers in a manner that will not cause containers to rupture or leak.		40 CFR 264.173(b) 401 KAR 34:180 Section 4(2)
Temporary storage of LLW	Ensure that radioactive waste is stored in a manner that protects the public, workers, and the environment and that the integrity of waste storage is maintained for the expected time of storage.	Management of LLW at a DOE facility — **TBC.**	DOE M 435.1-1 (IV)(N)(1)
	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water.		DOE M 435.1-1 (IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage.		DOE M 435.1-1 (IV)(N)(3)
	Shall be managed to identify and segregate LLW from mixed waste.		DOE M 435.1-1 (IV)(N)(6)
Packaging of LLW (e.g., PPE, rags)	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container.	Storage of LLW in containers at a DOE facility — **TBC.**	DOE M 435.1-1 (IV)(L)(1)(a)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.		DOE M 435.1-1 (IV)(L)(1)(b)
	Containers shall be marked such that their contents can be identified.		DOE M 435.1-1 (IV)(L)(1)(c)

Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
Temporary storage of PCB waste (e.g., PPE, rags) in a container(s)	Container(s) shall be marked as illustrated in 40 CFR 761.45(a).	Storage of PCBs and PCB Items at concentrations ≥50 ppm or items contaminated from a known source of ≥ 50 ppm PCBs for disposal **—applicable.**	40 CFR 761.40(a)(1)
	Storage area must be properly marked as required by 40 CFR 761.40(a)(10).		40 CFR 761.65(c)(3)
	Any leaking PCB Items and their contents shall be transferred immediately to a properly marked, non-leaking container(s).		40 CFR 761.65(c)(5)
	Container(s) shall be in accordance with requirements set forth in DOT HMR at 49 CFR 171-180.		40 CFR 761.65(c)(6)
	Shall be dated when they are removed from service and the storage shall be managed so that PCB Items can be located by this date [Note: Date should be marked on the containers].		40 CFR 761.65(c)(8)
Storage of PCB waste and/or PCB/ radioactive waste in a RCRA-regulated container storage area	Does not have to meet storage unit requirements in 40 CFR 761.65(b)(1) provided unit:	Storage of PCBs and PCB Items designated for disposal **—applicable.**	40 CFR 761.65(b)(2)
	• is permitted by EPA under RCRA 3004;		40 CFR 761.65(b)(2)(i)
	• qualifies for interim status under RCRA 3005;		40 CFR 761.65(b)(2)(ii)
	• is permitted by an authorized state under RCRA 3006; and		40 CFR 761.65(b)(2)(iii)
	• PCB spills cleaned up in accordance with subpart G of 40 CFR 761.		40 CFR 761.65(c)(1)(iv)
Storage of PCB/radioactive waste in containers	For liquid wastes, containers must be nonleaking;	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performance standards— **applicable.**	40 CFR 761.65(c)(6)(i)(A)
	For nonliquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 CFR 761.65(b)(1)(ii); and		40 CFR 761.65(c)(6(i)(B)
	For both liquid and nonliquid wastes containers must meet all regulations and requirements pertaining to nuclear criticality safety.		40 CFR 761.65(c)(6)(i)(C)
	Treatment/Disposal		
Transport to wastewater treatment facility	All tank systems, conveyance systems, and ancillary equipment used to store or transport waste to an on-site NPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards.	On-site wastewater treatment units that are subject to regulation under Section 402 or Section 307(b) of the CWA (NPDES-permitted)— **applicable.**	40 CFR 270.1(c)(2)(v) 401 KAR 38:010 Section 1(2)(b)(5)
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility.	Generation for disposal of LLW at a DOE facility—TBC.	DOE M 435.1-1(IV)(O)
Disposal of LLW at an off-site disposal facility	LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility.	Generation for disposal of LLW—TBC.	DOE M 435.1-1(IV)(J)(2)
Disposal of RCRA/ TSCA waste at an off-site commercial facility	Meet authorized limits established in accordance with basic dose limits and consistent with guidelines contained in DOE-EH guidance prior to release.	Release of hazardous wastes potentially containing residual radioactive material throughout the volume—TBC.	DOE Order 5400.5(II)(5)(c)(6) and 5400.5(IV)(5)(a)

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Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
	Authorized limits shall be consistent with limits and guidelines established by other applicable Federal and State laws.		
Disposal of bulk PCB remediation waste	Shall be disposed of • in a hazardous waste landfill permitted by EPA under 3004 of RCRA, • in a hazardous waste landfill permitted by a State authorized under 3006 of RCRA, or • in a PCB disposal facility approved under 40 CFR 761.60.	Bulk PCB remediation waste (as defined in 40 CFR 761.3) that has been de-watered and with a PCB concentration ≥ 50 ppm — **applicable.**	40 CFR 761.61(a)(5)(i)(B)(2)(iii)
Performance-based disposal of PCB remediation waste	May dispose by one of the following methods: • in a high-temperature incinerator approved under Section 761.70(b), • by an alternate disposal method approved under Section 761.60(e), • in a chemical waste landfill approved under Section 761.75, • in a facility with a coordinated approval issued under Section 761.77, or • through decontamination in accordance with Section 761.79.	Disposal of nonliquid PCB remediation waste — **applicable.**	40 CFR 761.61(b)(2) 40 CFR 761.61(b)(2)(i) 40 CFR 761.61(b)(2)(ii)
Disposal of PCB cleanup wastes (PPE, rags, non-liquid cleaning materials)	Shall be disposed of in one of these: • in a facility permitted, licensed or registered by a State to manage municipal solid waste under 40 CFR 258 or nonmunicipal, nonhazardous waste subject to **40** CFR 257.5 thru 257.30; • in a RCRA Subtitle **C** landfill permitted by a State to accept PCB waste, • in an approved PCB disposal facility, or • through decontamination under 40 CFR 761.79(b) or (c).	Generation of nonliquid PCBs at any concentration during and from the cleanup of PCB remediation waste — **applicable.**	40 CFR 761.61(a)(5)(v)(A)
Disposal of PCB cleaning solvents abrasives, and equipment	May be reused after decontamination in accordance with 761.79.	Generation of PCB wastes from the cleanup of PCB remediation waste — **applicable.**	40 CFR 761.61(a)(5)(v)(B)
Disposal of RCRA hazardous waste in a land-based unit	May be land disposed only if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2 (401 KAR 37:005), of RCRA restricted waste — **applicable.**	40 CFR 268.40(a) 401 KAR 37:040 Section 1
	Soil must be treated according to the applicable treatment standards of 40 CFR 268.49(c) or according to the **UTS** specified in 40 CFR 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, **as** defined in 40 CFR 268.2 (401 KAR 37:005), of RCRA- restricted hazardous waste — **applicable.**	40 CFR 268.49(b)
	May be land disposed **if** it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 CFR 268.45 (401 KAR 37:040) before land disposal or the debris is treated to the waste-specific treatment standard provided in 40 CFR 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 CFR 268.2 (401 KAR 37:005), of RCRA- restricted hazardous debris — **applicable.**	40 CFR 268.45(a) 401 KAR 37:040 Section 6(1)

Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
Disposal of treated hazardous debris	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 CFR 268.45, which no longer exhibits a characteristic is not a hazardous waste and need not be managed in a RCRA Subtitle C facility. Hazardous debris contaminated with listed waste that is treated by mobilization technology must be managed in a RCRA Subtitle C facility.	Treated debris contaminated with RCRA-listed or characteristic waste — applicable.	40 CFR 268.45(c) 401 KAR 37:040 Section 6(3)
Disposal of hazardous debris treatment residues	Except as provided in 40 CFR 268.45(d)(2) and (d)(4), residues from treatment of hazardous debris must be separated.from debris, and such residues are subject to the waste-specific treatment standards for the wastes contaminating the debris.	Treated debris contaminated with RCRA-listed or characteristic waste — applicable.	40 CFR 268.45(d)(1) 401 KAR 37:040 Section 6(4)(a)
Disposal requirements for particular RCRA waste forms and types	Must not be placed in a landfill unless the waste and the landfill meet applicable provisions of 40 CFR Part 268 (401 KAR 37) and	Disposal of ignitable or reactive RCRA waste — applicable.	40 CFR 264.312(a) 401 KAR 34:230 Section 7
	• the resulting waste, mixture or dissolution of material no longer is reactive or ignitable; and		40 CFR 264.312(a)(1) 401 KAR 34:230 Section 7(1)
	• 40 CFR 264.17(b) is complied with (see below).		40 CFR 264.312(a)(2) 401 KAR 34:230 Section 7(2)
Treatment and Disposal of ignitable, reactive, or incompatible RCRA wastes	Must take precautions to prevent reactions that • generate extreme heat, pressure, fire or explosion, or produce uncontrolled fumes or gases which pose a risk of fire or explosion; • produce uncontrolled toxic fumes or gases that threaten human health or the environment; • damage the structural integrity of the device or facility.	Operation of a RCRA facility that treats, stores, or disposes of ignitable, reactive, or incompatible wastes — applicable.	40 CFR 264.17(b) 401 KAR 34:020 Section 8(2)
	Incompatible wastes shall not be placed in the same landfill cell.		40 CFR 264.313 401 KAR 34:230 Section 8
Disposal of bulk or noncontainerized liquids in a RCRA landfill	May not dispose of bulk or noncontainerized liquid hazardous waste or hazardous waste containing free liquids in any landfill.	Placement of bulk or noncontainerized RCRA hazardous waste — applicable.	40 CFR 264.314(b) 401 KAR 34:230 Section 9(1)
Disposal of containers in RCRA landfill	May not place containers holding free liquid in a landfill unless the liquid is mixed with an absorbent, solidified, removed, or otherwise eliminated.	Placement of containers containing RCRA hazardous waste in a landfill — applicable.	40 CFR 264.314(d) 401 KAR 34:230 Section 9(2)
	Sorbents used to treat free liquids to be disposed of in landfills must be nonbiodegradable as described in 40 CFR 264.315(e)(1).		40 CFR 264.314(e) 401 KAR 34:230 Section 9(4)
	Unless they are very small, containers must be either at least 90% full when placed in the landfill, or crushed, shredded, or similarly reduced in volume to the maximum practical extent before burial in the landfill.		40 CFR 264.315 401 KAR 34:230 Section 10
Disposal of TSCA PCB wastes	PCBs and PCB items shall be placed in a manner that will prevent damage to containers or articles.	Disposal of PCBs or PCB Items in chemical waste landfill — applicable.	40 CFR 761.75(b)(8)(i)

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Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
	Other wastes that are not compatible with PCBs shall be segregated from the PCBs throughout the handling and disposal process.		
	May be disposed of provided such waste is pretreated and/or stabilized (e.g., chemically fixed, evaporated, mixed with dry inert absorbent) to reduce its liquid content or increase its solid content so that a nonflowing consistency is achieved to eliminate the presence of free liquids prior to final disposal.	Disposal of PCB bulk liquids not exceeding 500 ppm–applicable.	40 CFR 761.75(b)(8)(ii)
	May be disposed of if container is surrounded by an amount of inert sorbent material capable of absorbing all of the liquid contents of the container.	Disposal of PCB container with liquid PCB between 50 ppm and *500* ppm — applicable.	40 CFR 761.75(b)(8)(ii)
Packaging of LLW for disposal (e.g., PPE, sludges)	Must not be packaged for disposal in cardboard or fiberboard boxes.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(b)
	Must be solidified or packaged in sufficient absorbent material to absorb twice the volume of liquid.	Generation of liquid LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(c)
	Shall contain as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.	Generation of solid LLW containing liquid for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(d)
	Must not be capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures or of explosive reaction with water.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(e)
	Must not contain, or be capable of generating, quantities of toxic gases, vapor, or fumes.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(f)
	Must not be pyrophoric.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(g)
	Gaseous waste must be packages at a pressure not to exceed 1.5 atmospheres at 20°C.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(h)
	Wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the nonradiological materials.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(1)(I)
	Must have structural stability either by processing the waste or placing the waste in a container or structure that provides stability after disposal.	Generation of LLW for disposal at a LLW disposal facility — relevant and appropriate.	902 KAR 100:021 Section 7(2)(a)(2)

Potential action-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
	Must be converted into a form that contains as little free-standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.	Generation of liquid LLW or LLW containing liquids for disposal at a LLW disposal facility **—relevant and appropriate.**	902 KAR 100:021 Section 7(2)(b)
	Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.	Generation of LLW for disposal at a LLW disposal facility **—relevant and appropriate.**	902 KAR 100:021 Section 7(2)(c)
	Institutional controls		
Uranium- and thorium-bearing LLW left in place	Access to a property and use of material should be controlled through appropriate administrative and physical controls, designed to be effective to the extent reasonable for at least 200 years.	On-site material contaminated by residual radioactive material (uranium and thorium)—TBC.	DOE Order 5400.5(IV)(6)(d)(1)(e)
	Transportation		
Transportation of LLW offsite	Shall be packaged and transported in accordance with DOE O 1460.1A and DOE O 460.2.	Shipment of LLW off site—**TBC.**	DOE M 435.1-1(I)(1)(E)(11)
	To the extent practicable, the volume of waste and number of shipments shall be minimized.		DOE M 435.1-1(IV)(L)(2)
Transportation of PCB wastes offsite	Must comply with the manifesting provisions at 40 CFR 761.207 through 218.	Relinquishment of control over PCB wastes by transporting, or offering for transport **—applicable.**	40 CFR 761.207 (a)
Transportation of hazardous waste offsite	Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting; Section 262.30 for packaging; Section 262.31 for labeling; Section 262.32 for marking; Section 262.33 for placarding; Section 262.40, 262.41(a) for record keeping requirements; and Section 262.12 to obtain EPA ID number.	Off-site transportation of RCRA hazardous waste **—applicable.**	40 CFR 262.10(h) 401 KAR 32:030
	Must comply with the requirements of 40 CFR 263.11-263.31. A transporter who meets all applicable requirements of 49 CFR 171-179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263.	Transportation of hazardous waste within the United States requiring a manifest **—applicable.**	40 CFR 263.10(a) 401 KAR 33:010
Transportation of hazardous waste onsite	The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 262.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way **—applicable.**	40 CFR 262.20(f)
	A generator who transports, or offers for transportation, hazardous waste for off-site treatment, storage, or disposal shall prepare a manifest. In accordance with 401 KAR 32:005 Section 1(186), the term offsite means "properties noncontiguous to the site."	Transportation of hazardous waste on contiguous property in the Commonwealth of Kentucky—applicable.	401 KAR 32:020 Section 1(1)

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Potential action-specific **ARARs** and TBC guidance for the Sediment Basin Removal Action (continued)

Action	Requirements	Prerequisite	Citation
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at **49** CFR 171-180.	Any person who, under contract with an department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material—applicable.	**49** CFR 171.1(c)

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = Code ***of Federal Regulations***
DOE = U.S. Department of Energy
DOE M = Radioactive Waste Management Manual
DOE **O** = DOE Order 435.1 Radioactive Waste Management
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
EMWMF = Environmental Management Waste Management Facility
EPA = U.S. Environmental Protection Agency
> = greater than
< = less than
≥ = greater than or equal to
≤ = less than or equal to
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act of 1975
KAR = Kentucky Administrative Regulations
ID = identification number
LLW = low-level (radioactive) waste
mrem = millirem
mSv = millisievert
PCB = polychlorinated biphenyl
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery **Act** of 1976
ROD = record of decision
TBC = to be considered
TSCA = Toxic Substances Control Act of 1976
WAC = waste acceptance criteria

Potential chemical-specific ARARs and TBC guidance for the Sediment Basin Removal Action

Medium/action	Requirements	Prerequisite	Citation
Releases of radionuclides into the environment	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Presence of radioactive materials other than excluded sources — **relevant and appropriate.**	10 CFR 20.1301(a) 902 KAR 100:019 Section 10(1)
	Shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve doses to members of the public that are ALARA.	Presence of radioactive materials other than excluded sources — **relevant and appropriate.**	10 CFR 20.1101(b) 902 KAR 100:015 Section 2

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CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = *Code of Federal Regulations*
EDE = effective dose equivalent
KAR = Kentucky Administrative Regulations
mrem = millirem
TBC = to be considered

Potential location-specific ARARs and TBC guidance for the Sediment Basins Removal Action

Location characteristic(s)	Requirements	Prerequisite	Citation
	Floodplaitis / Wetlands		
Presence of floodplain as defined in 10 CFR 1022.4(i)	Avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains. Measures to mitigate adverse effects of actions in a floodplain include, but are not limited to minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas as provided in 10 CFR 1022.12(a)(3).	Federal actions that involve potential impacts to, or take place within, floodplains — applicable.	10 CFR 1022.3(a)
	Evaluate potential effects of any action taken in a floodplain. Identify, evaluate, and implement alternative actions that may avoid or mitigate adverse impacts on floodplains.		10 CFR 1022.3(c) and (d)
	Design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values.		10 CFR 1022.5(b)
Presence of a base floodplain as defined in 401 KAR 4:060 Section 1	No fill, deposit, obstruction, excavation, storage of materials, or structure, either alone or in combination with existing or future similar works, which may adversely affect the efficiency or capacity of the regulatory floodway, existing streams, or drainage facilities shall be placed in the regulatory floodway.	Construction across, along, or adjacent to a stream (i.e., base floodplain) or in the regulatory floodway of a stream — applicable.	401 KAR 4:060 Section 4 (1)
Presence of wetlands as defined in 10 CFR 1022.4(v)	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy and modification of wetlands. Measures to mitigate adverse effects of actions in a wetland include, but are not limited to minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas as provided in 10 CFR 1022.12(a)(3).	Federal actions that involve potential impacts to, or take place within, wetlands — applicable.	10 CFR 1022.3(a)
	Evaluate potential effects of any action taken in a floodplain. Identify, evaluate, and implement alternative actions that may avoid or mitigate adverse impacts on floodplains.		10 CFR 1022.3(c) and (d)
	Design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values.		10 CFR 1022.5(b)
	Aquatic resources		
Within area impacting stream or any other body of water - and- presence of wildlife resources (e.g., fish)	The effects of water-related projects on fish and wildlife resources and their habitat should be considered with a view to the conservation of fish and wildlife resources by preventing loss of and damage to such resources.	Action that impounds, modifies, diverts, or controls waters, including navigation and drainage activities — relevant and appropriate.	Fish and Wildlife Coordination Act (16 *USC* 661 *et seq.)*

Potential location-specific ARARs and TBC guidance for the Sediment Basin Removal Action (continued)

Location characteristic(s)	Requirements	Prerequisite	Citation
Location encompassing aquatic ecosystem as defined in 40 CFR 230.3(c)	Except as provided under Section 404(b)2 of the CWA, no discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact.	Action that involves the discharge of dredged or fill material into "waters of the U.S.," including jurisdictional wetlands — applicable.	40 CFR 230.10(a)
	No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps per 40 CFR 230.70 *et seq.* have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.		40 CFR 230.10(d)
	Cultural resources		
Presence of archaeological resources	May not excavate, remove, damage, or otherwise alter or deface such resource unless by permit or exception.	Action that would impact archaeologic resources on public land — applicable.	43 CFR 7.4(a)
	Must protect any such archaeological resources if discovered.	Excavation activities that inadvertently discover archaeologic resources — applicable.	43 CFR 7.5(b)(1)
Presence of human remains, funerary objects, sacred objects, or objects of cultural patrimony for Native Americans	Must stop activities in the area of discovery and make a reasonable effort to secure and protect the objects discovered.	Excavation activities that inadvertently discover such resources on federal lands or under federal control — applicable.	43 CFR 10.4(c)
	Must consult with Indian tribe likely to be affiliated with the objects to determine further disposition per 40 CFR 10.5(b).	Excavation activities that inadvertently discover archaeologic resources — applicable.	43 CFR 10.4(d)
	Endangered, threatened or rare species		
Presence of endangered or threatened species critical habitat.	No waste site or facility shall result in the destruction or adverse modification of the critical habitat of an endangered or threatened species or candidate species listed pursuant to 16 USC 1531 et *seq.* (the Endangered Species Act of 1983 as amended).	Action would impact critical habitat. applicable.	401 KAR 30:031 Section 3(2)
Presence of migratory birds as defined in 50 CFR 10.13, and their habitats	• 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.	Action that is likely to impact "migratory birds" — TBC.	Executive Order 13186, GPO Compilation of Presidential Documents, January 11, 2001

ARARs = applicable or relevant and appropriate requirements
ARAP = Aquatic Resource Alteration Permit
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = Code of Federal Regulations
KAR = Kentucky Administrative Regulations
TBC = to be considered
USC = United States Code

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